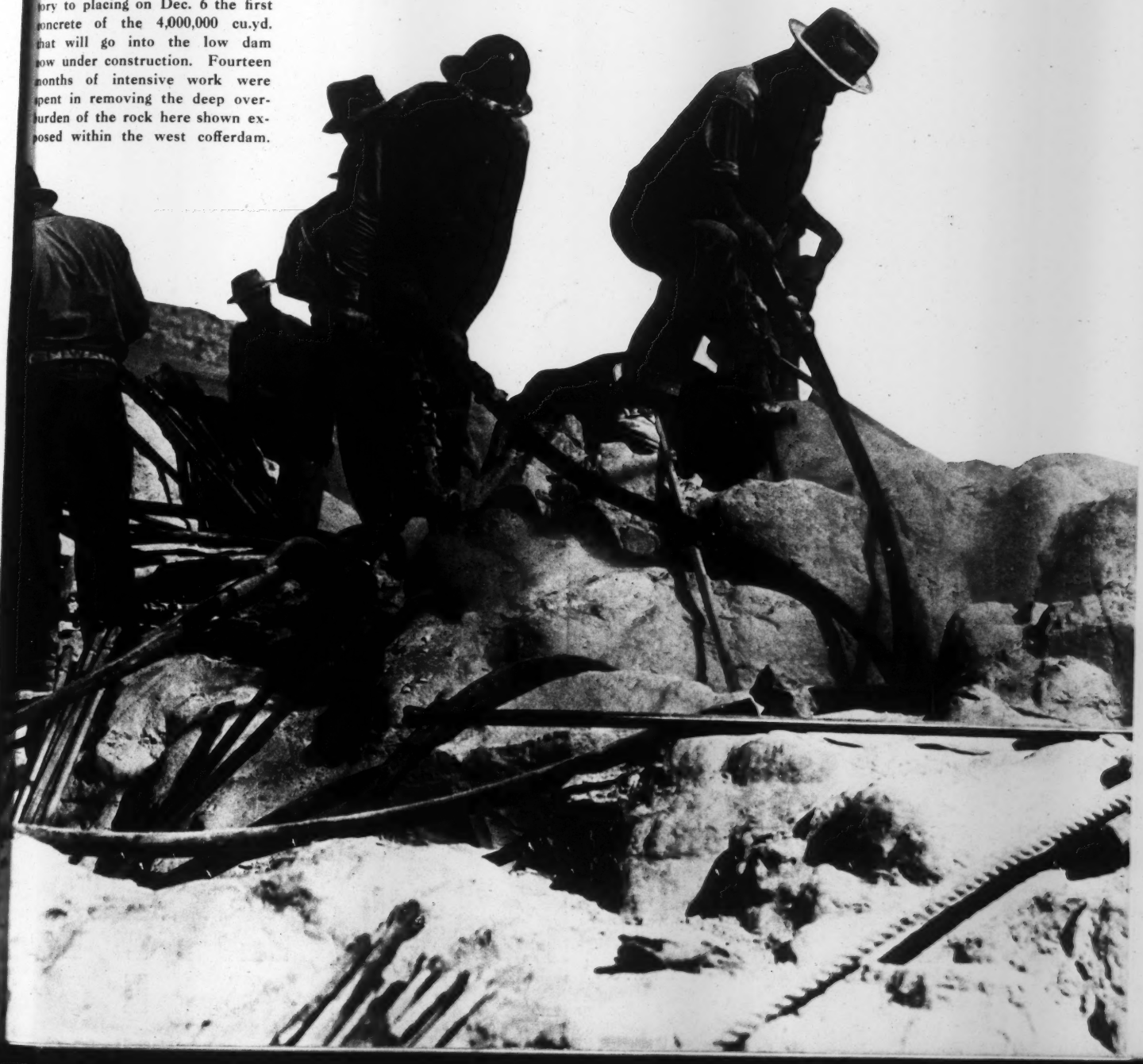
DEC 17 1935

Engineering News-Record

McGraw-Hill Publishing Company, Inc. December 12, 1935 Twenty-five Cents, Five Dollars per Year

FINAL CLEAN-UP of the rock in the foundation of Grand Coulee Dam preparatory to placing on Dec. 6 the first concrete of the 4,000,000 cu.yd. that will go into the low dam now under construction. Fourteen months of intensive work were spent in removing the deep overburden of the rock here shown exposed within the west cofferdam.



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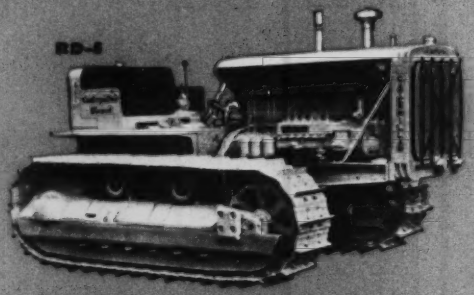

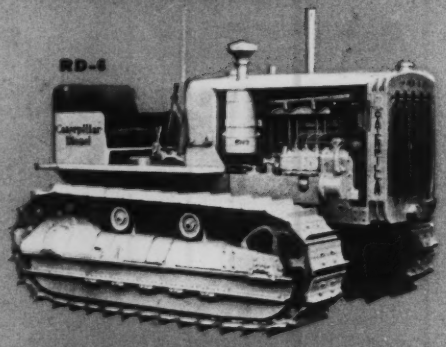

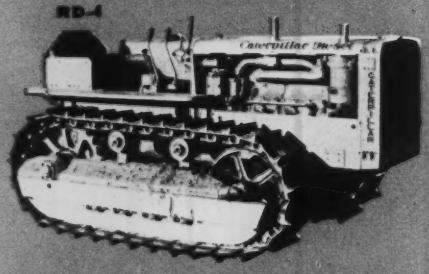

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As to Highway Safety-II

(Continued from last week's issue)

LAST WEEK this page pointed out that the current efforts in behalf of highway safety should not be concentrated on reforming the drivers. The fact is that the highway engineer knows how to design roads that can reduce substantially the number of highway accidents: he knows also, of course, that it is not economically practicable to provide universally his engineering safeguards. For all our pious horror, we, as a community, still set a dollars and cents limit to what we are willing to pay to reduce the chances of "sudden death." But despite that limitation the engineer knows that he can prescribe economically sound remedies for many accidents that we now take for granted or blame on the drivers.

It would be interesting to know just how many of those who thrill so responsively to the "frightfulness" crusade are amongst those who have dallied with the notion that our highways are "overbuilt" and that we might economize through a "road-building holiday." How many have viewed indifferently the wholesale and cynical diversion to other uses of the special taxes paid by motorists for the explicit purpose of improving the highways? Is it possible that their recklessness in this respect may contribute to highway accidents as well as recklessness at the steering wheel?

Surely few of those who seem so indifferent to highway improvement would care to board a super-speed railroad train, knowing that the engineers had failed to provide a track adequate for such service. They would be somewhat alarmed if they should suspect that, for reasons of economy, they must travel over track laid to the standards of 15 or 20 years ago and not since rebuilt to meet the needs of modern traffic.

BUT is it less hazardous for 25,000,000 automobiles of increasing speed and power to operate over a track system much of which was built for the traffic of 15 or 20 years ago? During recent years many miles of streets and highways have been built new or improved to meet the needs of modern motor traffic; but many miles of the highways that were first improved now must be rebuilt to new standards. The science of highway engineering has kept abreast of the need but those who must apply it in practice have not always had the resources to keep the physical plant up to date. Hundreds of curves must be eased off and rebanked, grades must be reduced, more trustworthy surfacing must be laid, busy stretches must be widened with appropriate center strips to separate opposing traffic lanes or relieved by new routes, many grade-crossings must be eliminated and others more adequately protected, every mile of the main routes must be restudied to improve visibility in the light of modern speeds. Other aspects of the physical highway plant have a vital influence on highway safety and those who honestly and earnestly want to do something about it will take all these into account.

Much can be accomplished in behalf of highway safety if we give due attention to all the factors involved. We can count on the manufacturers continuing to build safer cars for they have a vast stake in the consistent development of motor transportation; any trend toward arbitrarily restricting the use of cars or toward imposing on the car some form of mechanical speed control will constitute a grave setback.

WE must attack the driver hazard by every available means. In every state reasonable standards of proficiency and responsibility should be required of the citizen before he is given the right to drive a motor car on the public highway. Intelligent traffic regulations must be supplemented by intelligent enforcement. By every possible means we should educate the people constantly to more competent drivership; for those quarters in which no other incentive appears to work, extreme measures may be contrived.

But while we thus work on the drivers let us not forget that the track over which they must drive their cars still is a vital factor in highway safety. Those charged with the building and maintenance of the public highways can help materially in the fight for safer highways by putting into practice what engineering science has taught us during recent years. But they need the wherewithal to do it, and every citizen who would do his utmost in behalf of highway safety will see to it that no economy agitation is permitted to obstruct the provision of the funds they so sorely need to do their part.

Willard Chevalier

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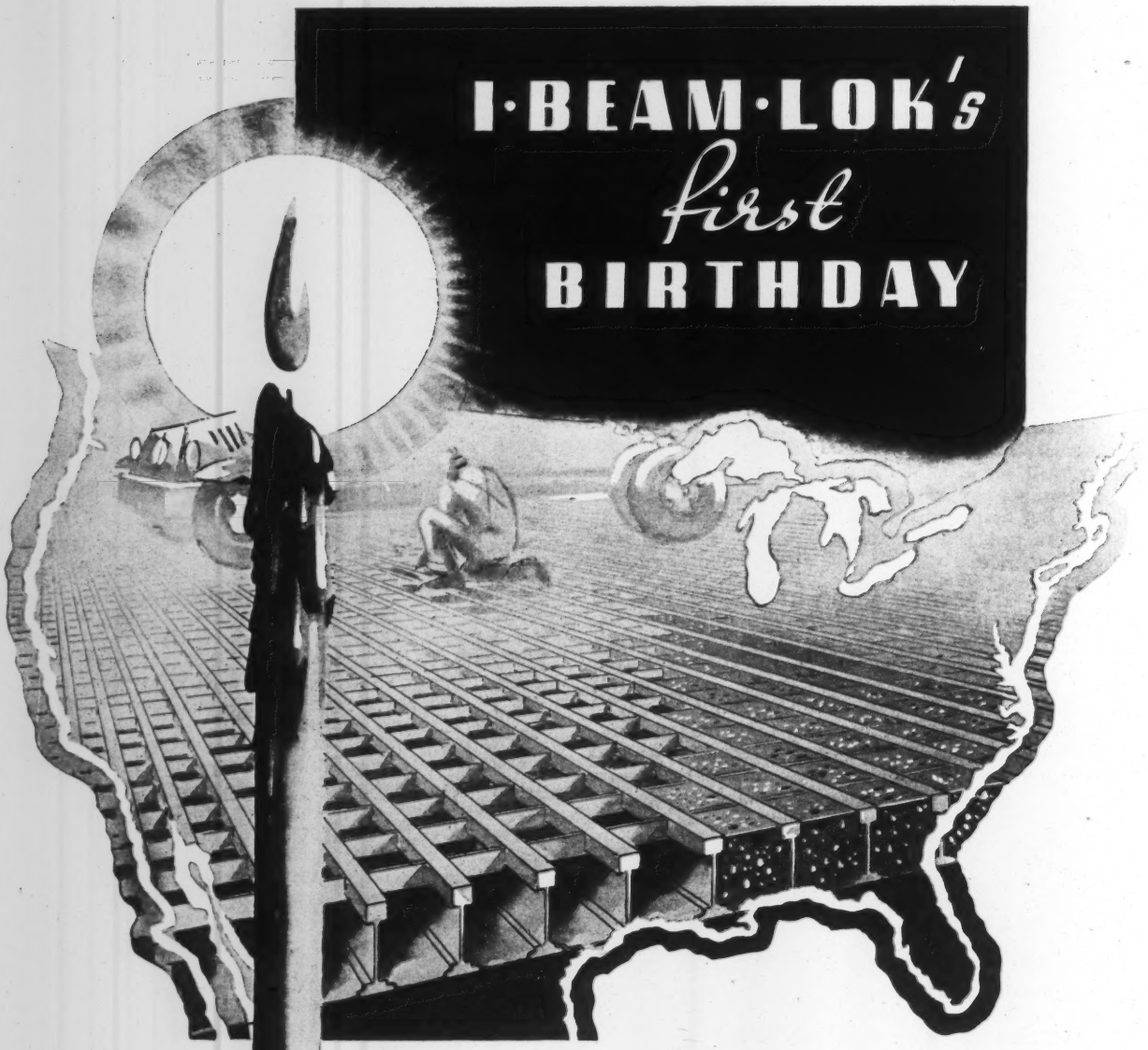
I-BEAM-LOK's *first* BIRTHDAY



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In the News:

CHICAGO placed its 75-m.g.d. Calumet sewage-treatment plant in operation on Dec. 5. Serving a population of 238,000 in the area south of 87th St., the new plant is the latest of the series, planned to permit reduction of Lake Michigan diversion to 1,500 sec.-ft.

AUTHORIZATION of a $1,208,000 WPA expenditure for a 333-acre recreation reservoir near Kansas City, Kan., was made on Dec. 3. Wyandotte County furnishes the site at a cost of $111,000. The dam to be built, the largest in the state, will be an earth structure 1,550 ft. long, 90 ft. high and 550 ft. wide at the base. About 1,000,000 yd. of earth and rock excavation is involved.

PWA APPROVAL has been granted for the $4,583,000 loan to the Willacy County Irrigation District for a system of canals in the Lower Rio Grande Valley. Approval had been held up pending the outcome of charges of conspiracy against the officials of the district; the indictments were dismssed.

A BILL designed to place housing and slum clearance on a permanent basis, as distinct from the present emergency basis, is being prepared for introduction in the next Congress by Senator Wagner of New York. An initial appropriation of $800,000,000 is being planned. This would be used as a federal subsidy to aid local bodies in providing low-rent housing.

WATER FROM THE NORTH PLATTE RIVER was turned into the main supply canal of the North Platte Power & Irrigation District on Dec. 1 at the diversion dam near the town of Keystone, 45 miles from the Sutherland storage reservoir. Work on the project has been pushed in order to be able to store water this winter.

BIDS for a new water-power plant to serve the Noranda Mines in Quebec and plans for an extension of the water-power plant of the city of Sherbrooke are taken in Canada as the first signs of a revival of hydro-power development.

PUBLIC HEARINGS have been begun at Chicago on the type of superstructure to be built in the metropolitan area to provide better highway traffic facilities, chiefly to the West Side.

BIDS for the first sections of Detroit's $20,000,000 sewerage program were opened on Dec. 3. To get PWA funds, the contracts have to be let by the deadline date, Dec. 15.

ALL SURVEY WORK and construction on the Gila Valley irrigation project in Arizona have been stopped by Secretary Ickes pending an investigation of the agricultural possibilities of the area. Mr. Ickes' action was taken at the request of the Secretary of Agriculture and bears no relation, it is stated, to the unsettled controversy between Arizon and California over Colorado River water.

THE FIRST of the 4,000,000 cu.yd. of concrete that are to go into Grand Coulee Dam was placed on Dec. 6, as noted on the cover. The rock there shown exposed was uncovered as the result of one of the most unusual foundation excavation operations evef carried out.

HEAVY RAINS have caused serious flooding in Houston, Tex., with further damage expected from the water, which was stilll rising as this was written.

In This Issue:

A SEWAGE-TREATMENT PLANT that is unique in many of its details recently was put into service at Cedar Rapids, Iowa; its most notable element is provision for separate plant for pretreatment of packing-house waste. Pretreatment appeared desirable because industrial wastes make up an unusually large part of the load on the municipal disposal plant.

THE DAM AND DIKE for Cajalco Reservoir on the aqueduct of the Metropoltian Water District of Southern California, large earthfill structures, are to be built according to the Proctor method of soil compaction control. The 194-ft. high dam will be the largest structure yet built in which that method has been employed.

PRECAST CONCRETE BLOCK LINING, a recent development in tunnel construction, was used advantageously in driving a 6-ft. storm-drain tunnel at Middleton, N. Y.

BECAUSE of the unprecedented amount of material to be placed hydraulically in Fort Peck Dam, a total of 100,000,000 cu.yd., the design of the dredging and pumping plant was made the subject of an exhaustive study. As a result, some notable innovations in dredge construction have been incorporated in the plant.

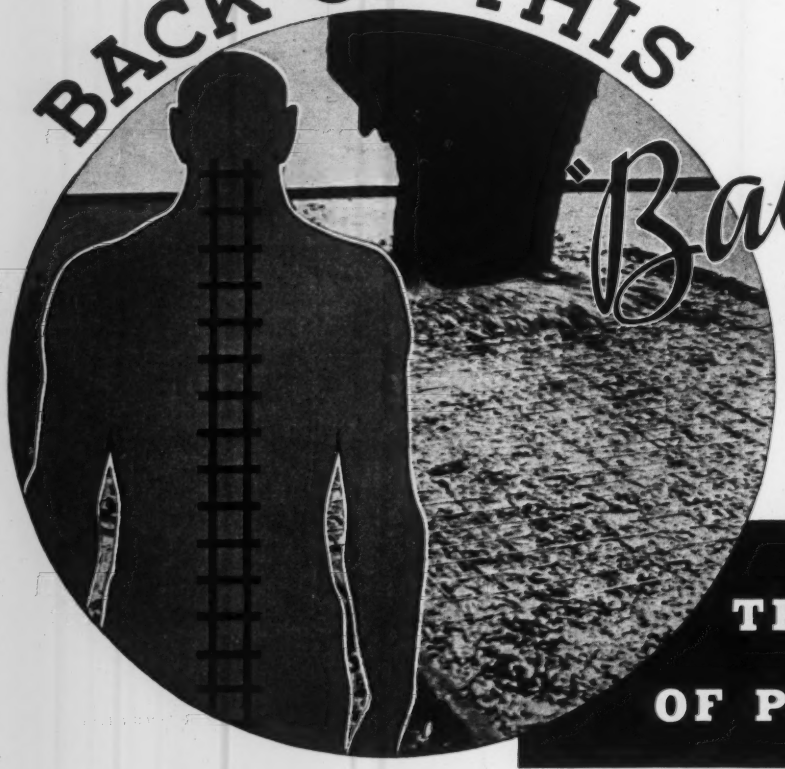
THE USE OF MODELS in structural analysis, which has expanded so greatly during the past ten years, is further aided by new apparatus developed by William J. Eney, of Baltimore, and is described in this issue. The cardboard models used are low in cost, and since the deflections dealt with are relatively large, microscopes are not necessary.

BRICK FACING of a concrete rigid-frame bridge in New Hampshire produced an attractive structure and provided needed employment in a brick-manufacturing community.

THE REMARKABLE FIVE-YEAR PROGRAM of repairing the Panama Canal lock gates, worn by years of operation, was completed this year. Procedure used in unhinging, repairing and placing the 800-ton gates is outlined by Clinton Morse, junior engineer, Panama Canal.

CURRENT HIGHWAY RESEARCH was reported at the meeting of the Highway Research Board of the National Research Council in Washington last week. The reports are summarized in this issue.

BACK OF THIS "Backbone" OF CONCRETE



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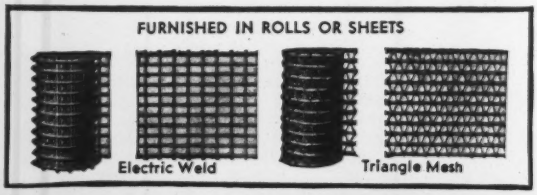

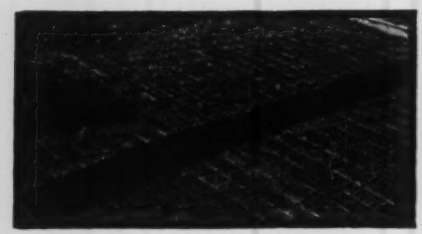

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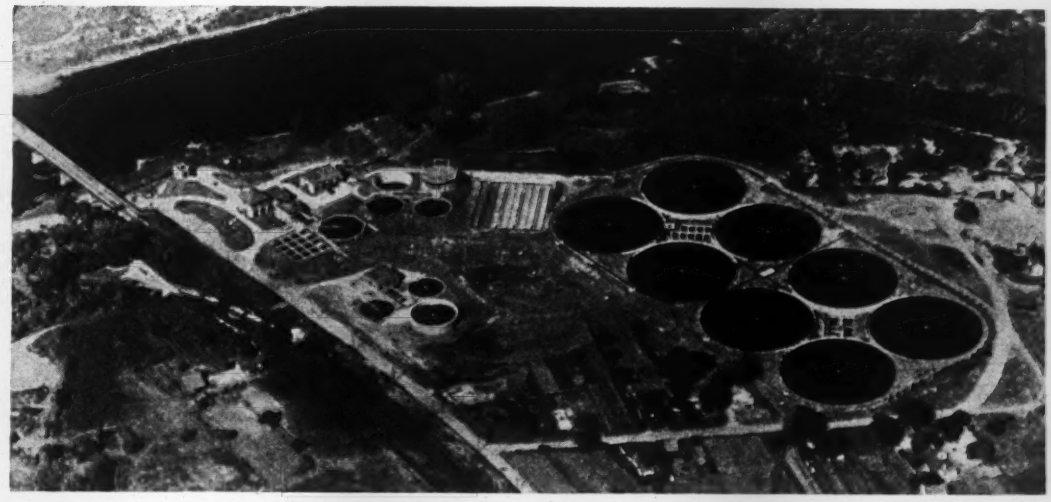


FIG. 1—TWO TREATMENT PLANTS for Cedar Rapids sewage. The separate pretreatment plant for packing-house wastes is shown in lower left center of the view. The battery of eight 167-ft.-diameter circular trickling filters on the right is the largest installation of its type in this country.

Domestic and Packing-House Wastes Treated Jointly at Cedar Rapids

With an industrial load equal to the domestic load, the sewage-treatment facilities of Cedar Rapids, Iowa, include essentially two plants of modern mechanized type—Eight circular trickling filters, the largest yet built, are served by two straight-line final clarifiers with a novel timeclock-operated sludge-flushing arrangement

A UNIQUE new sewage-treatment plant at Cedar Rapids, Iowa, is practically completed, with most of the plant units in routine operation, though some are still in the trial stage. It is one of the most complete plants yet built and includes a greater variety of equipment and facilities than is used elsewhere. The reason for this is the large industrial load, which is roughly equal to the domestic load and is of such nature that a separate and distinct pretreatment plant was indicated as necessary.

Characteristics of plant

The general city plant includes coarse rack screen, incinerator for screenings fired by sludge gas, automatic lift station, mechanically cleaned grit remover, air-blown grease remover, constant-duty radial-flow primary clarifier, four straight-line primary clarifiers for peak-load conditions, chlorination for odor control, twin dosing tanks with trapless siphons, trickling filters, and four straight-line final clarifiers. Both primary and secondary sludge are returned to a battery of four digestion tanks, two equipped with floating covers, a third with gasholder and a fourth for open storage. The gas sludge is utilized for fuel in an engine-driven generator set that furnishes power to drive the 68 motors on the site. This generator unit operates at continuous full load and its surplus output is metered onto the local utility company's line. The gas-engine cooling water passes through a waste-heat boiler and circulates constantly to the three covered digestion tanks to maintain optimum temperature conditions. The digested sludge is conditioned with ferric chloride and lime and is dewatered with a vacuum filter, but standby sludge-drying beds are also provided.

The packing-house waste pretreatment plant includes grease traps and 40-mesh screens operated on the packing-house property, after which the partly clarified effluent is handled entirely by the city department. It flows first to an automatic lift station, which delivers the sewage through a 14-in. pressure line (suspended from coil-spring supports on a plate-girder railroad bridge) to a storage tank to balance the peak rate of delivery while the packing plant is in operation. From this tank the waste

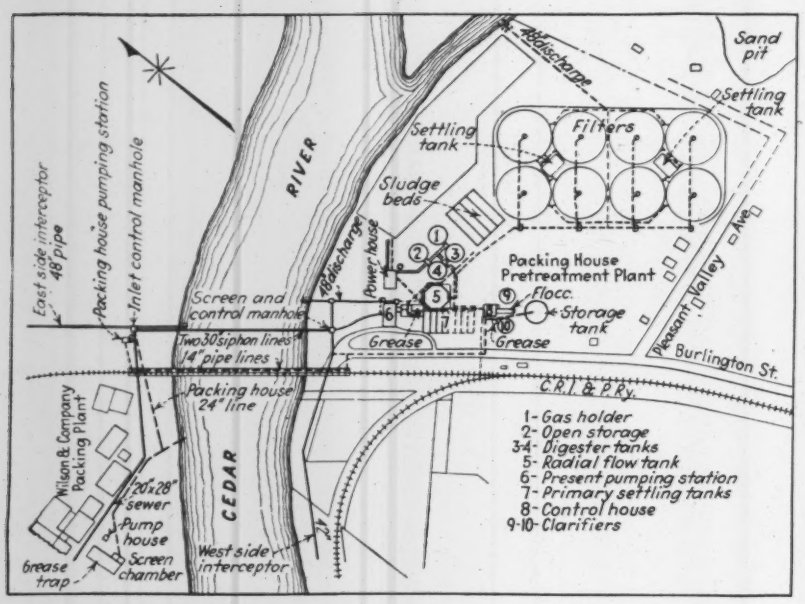


FIG. 2—PROXIMITY of the meat-packing company to the new municipal sewage-plant permitted economical construction of separate sewerage facilities for packing-house waste.

passes through a rate-of-flow controller to a cone-and-cylinder air-blown grease-removal unit, thence to a radial-flow primary clarifier, back to a flash mixer, where the alkalinity of the packing-house wastes is adjusted with sulphuric acid and where ferric chloride is added as a flocculating agent. Next it passes to a flocculator and then to a secondary clarifier, the effluent from which is collected in a clear well and delivered by a float-operated pump to the dosing tank of the general city plant, where it is mixed with the clarified city sewage before going on to the filters. Flocculated sludge is returned from the secondary clarifier to the flocculator in any desired quantity to assist in coagulation, and the surplus flocculated sludge is combined with primary sludge before being pumped to the digestion units.

Treatment requirements

Cedar Rapids, population 60,000, is an industrial midwestern town with a large number of food-processing plants which contribute a heavy load of meat packing, corn products and dairy wastes. All the industrial wastes, with the exception of those from the packing houses, are emptied directly into the city sewerage system. This carries a total flow of 6.5 m.g.d. of combined sewage having an average biochemical oxygen demand of 246 p.p.m. and a maximum demand of 600 p.p.m. The packing-house wastes contribute an additional flow of 1.2 m.g.d., with a B.O.D. avering 2,000 p.p.m. but sometimes reaching 4,000 p.p.m.

All units of the plant that would be difficult to extend were designed for expansion of the loadings to a 1970 population of 170,000, whereas clarifiers, filters and similar units were designed with a view to handling the present load plus a 17 per cent increase during the next ten years.

All general city wastes reach the plant through intercepting sewers serving some 100 miles of mains and laterals (*ENR*, July 25, 1935, p. 118). The plant is located on the west bank of the Cedar River, which runs through the center of the city. The East Side sewage (55 per cent) reaches the plant through two 30-in. cast-iron siphon lines. West Side sewage is delivered through a 42-in. outfall sewer.

The outfall sewers meet in a screen and incinerator building, where the flow passes through a mechanically cleaned vertical bar screen with ¾-in. openings. The screenings are dumped directly into the hopper of a gas-fired incinerator that consumes 8,000 cu.ft. of sludge gas per day.

A 48-in. gravity line from the screen pit leads to the wet well of the pumping station in which the floor of the pump pit is located 30 ft. below the high-water mark of the river. To avoid counter-weighting the building to resist uplift during flood periods of the river, the floor is subdrained through a system of open-joint sewer pipe laid in shallow trenches, backfilled with pea gravel, and the entire floor area is covered with a 6-in. bed of gravel. On top of this gravel a layer of tar paper preceded the placing of a 6-in. floor. The pump foundations are carried through the floor and gravel to rock foundation beneath. The subdrain lines discharge into a pit served by a 150-g.p.m. sump pump, which has successfully protected the plant against seepage water during two flood periods since construction.

The four sewage lift pumps are of the centrifugal type, driven by float-actuated 2,300-volt synchronous motors totaling 410 hp. The suction and discharge lines to the pumps are 14 in. in diameter, and the total dynamic head under average operating conditions is 50 ft. The discharge line of the largest pump is equipped with a solenoid-operated rotary plug valve, which saves 11 ft. of friction loss as against a standard flat-type check valve.

All pumps discharge into a 4x4-ft. concrete collection chamber which runs to the end of the building, passes down through a 48x24-in. venturi meter in the pump pit and into a rising well, 40 ft. in height, serving the influent channel of the grit-removal unit. This channel is provided with an overflow weir leading to a river bypass, which automatically protects further units in the plant against flooding in the case of emergency.

Grit and grease removal units

The grit-removal unit is built at an elevation such that a gravity flow is maintained from that point through the other units of the plant. Therefore it is raised above the level of the natural ground, and the space beneath is utilized as a service garage for the plant. This unit is mechanically cleaned, and grit is washed and delivered to a hopper discharging outside the building.

The grease-removal unit, of Imhoff type, is 30 ft. long, 15 ft. wide and 10 ft. deep, equipped with built-up wooden baffles and served by eight lines of perforated air pipe. This unit is shown in the immediate foreground of Fig. 3, note the gravity grease-removal chamber leading from left to right to the grease-concentrating well in the foreground. Provision has been made to introduce chlorine for odor control.

Proportional weirs

In Fig. 3, center foreground, and under the first grating shown, is a rising well delivering sewage upward from the outlet ports of the grease-removal unit to five proportional weirs under the next row of grating. The length of weirs is indicated by the subdivisions of the grating; the left-hand long weir serves the 70x11-ft. octagonal radial-flow clarifier, and the four short weirs supply the four straight-line clarifiers (16x65x13 ft.), ends of which are shown at the right of Fig. 3. All clarifiers are provided with skimming devices and with gravity channels leading to the grease concentrating well. Clear water from this well can be backdrained to the incoming sewage, leaving the grease on the surface.

The reason for the peculiar design of the clarifiers, using a combination of radial flow and straight lines, is as follows: The radial-flow clarifier is designed to operate at capacity continuously for 24 hours of the day. Because of the industrial nature of the town and the consequent high peak rates of de-

livery during operating hours, as well as the concentrated character of incidental trade wastes reaching the general city sewage flow, the question of odor control during low-flow hours had to be given consideration. Thus, to avoid an enforced and undesirably long detention period during the night-hours, the small straight-line clarifier units may be back-drained to the incoming sewage line as desired and refilled with the oncoming peak of the next day. This design was adopted on account of the variety of trade wastes in the general city sewage, although the packing-house waste, which is the major problem, is passed through an entirely separate pretreatment plant.

The space below the walkway between the octagonal and the straight-line clarifiers is developed as a pipe gallery and sludge-pumping compartment, with one duplex and one simplex displacement-type sludge pump.

Trickling filters

Eight circular trickling filters, each 167 ft. in diameter, are in operation. This constitutes not only the largest-diameter bed yet constructed in this country but one of the largest batteries of such units.

The filter units are fed from twin dosing tanks, and the effluent from each set of four filters flows to a rectangular sedimentation tank.

It was desired to obtain uniform distribution of clarified sewage over the entire 4-acre area, and this required careful balancing of friction losses. Because of this the net effective head at the center column of each of the eight filters is different, and the spacing and size of orifices on each of the 32 arms involved is therefore different. Final tests recently concluded indicate that the desired result has been obtained and that the maximum variation in uniformity of delivery when the plant is operating at typical peak-load rate of 8,800 g.p.m. is 2.8 per cent, with an average variation of only 1.2 per cent.

The filters are 6½-ft. average depth, using locally produced crushed limestone from 1½ to 2½ in. in size. In the selection of this material, the limestone was required to meet the following specification: no failures in five rattler cycles; not more than ten per cent loss by weight in ten cycles (loss includes particles and chips less than 1-in. ring measurement); and not more than 15 per cent loss of weight in twenty cycles of the standard sodium sulphate test as recommended in *Proceedings*, Am.Soc. C.E., September, 1929.

The filter floor is of ridge-and-channel type, the channels being half-round, cast in concrete with a shoulder to support half-round vitrified tile bedded in mortar. Subdrains are served by inspection galleries at each end, and the effluent outlet is a 3-ft.-wide open-flow channel provided with shear gates to direct the sewage either to the secondary clarifiers or to the river outlet. An upper gallery is enclosed and equipped with three ventilation ports and entrance manholes for each bed. Seven of the rotating distributors are equipped with wrought-iron distributor arms, and the eighth with aluminum arms.

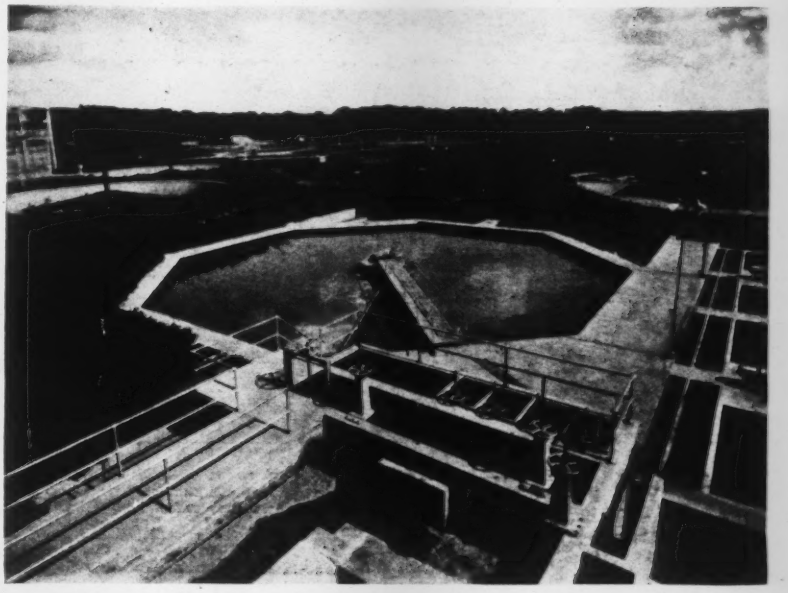


FIG. 3—AN OCTAGONAL CLARIFIER carries the normal flow with the four straight-line clarifiers (at right) available for peak loads. The grease removal unit is in the foreground.

Final clarifiers

Two pairs of final clarifiers serve the eight filter units. In order to provide rapid removal of the sludge settled out in these compartments with the least possible agitation, the following novel design was adopted. Instead of scraping the sludge the full 73-ft. length of the clarifiers to a sludge sump, cross-channels were cast in the floor at 11-ft. spacing, and each channel is provided with an outlet into a narrow gallery built between the two clarifiers. Each outlet is equipped with a quick-opening gate valve.

The flights of the scrapers are built with rubber-faced aprons which, when over the open channels, completely seal them except at the far end of the channel. The movement of the flight operates a cam, which opens the flushing valve when the channel is covered, and the size of opening is varied from end to end of the tank to accommodate the variable quantity of sludge collected. The mechanism is time-clock operated and, when moving at a rate of 1 ft. per minute, 11 min. of operation sweeps the entire floor and discharges the sludge to the center gallery. The mechanism can be thrown out of operation for any desired period by adjustment of the time switch.

From the collection sump at the end of the center gallery, a float-operated centrifugal sludge pump discharges either to the digestion tanks direct or to the incoming raw sewage ahead of the primary clarifiers. Because of possible submergence of this unit during periods of extreme high water it was deemed advisable to set the control house above high-water elevation.

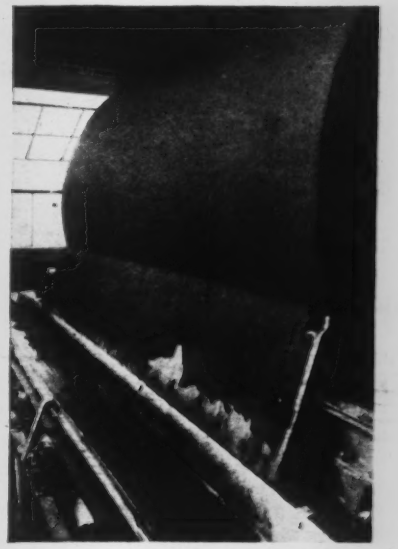


FIG. 4—DEWATERED SLUDGE from the vacuum filter is discharged on a 100-ft. belt conveyor that delivers the dried cake to trucks outside the building.

Sludge digesters

The digestion tanks, four in number, are 60 ft. in diameter and 27 ft. deep. Three of them are heated by 2-in. hot-water coils, eight in number, encircling the tank in the bottom third and set on inclined racks to secure maximum efficiency. The tanks are interconnected for

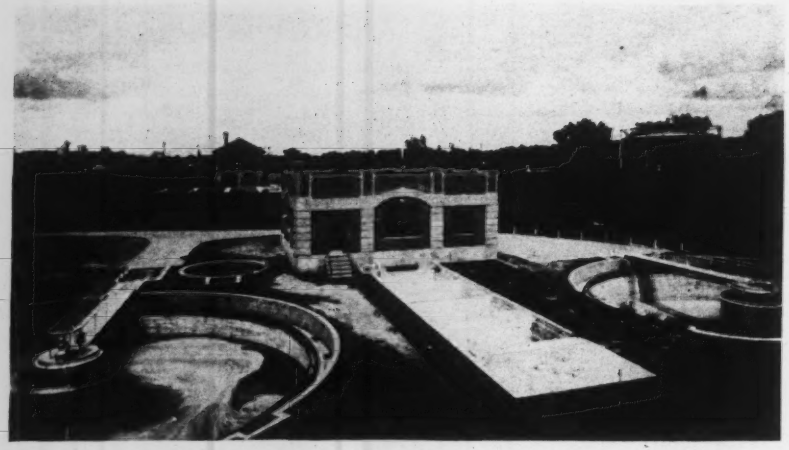


FIG. 5—PRETREATMENT PLANT for packing-house waste includes a control house, grease remover, primary clarifier, flash mixer, flocculator and secondary clarifier. A grease-concentrating well is at the left of the control house.

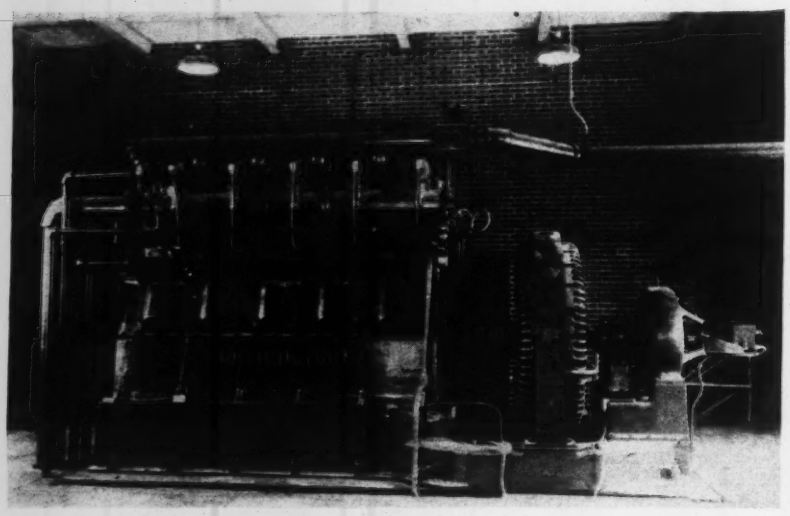


FIG. 6—SLUDGE-GAS ENGINE that drives a 150-kw. 2,300-volt generator synchronized with the local utility company circuit so that surplus power can be sold.

series or parallel operation and so-called stage digestion. Under present operating conditions raw sludge is alternately delivered to digesters 1 and 2 for four-day periods. Sludge from these two units is pumped to digester 3 covered by the gasholder of 60,000-cu.ft. capacity, and eventually passes to the open storage or to the drying beds or filter as desired. Digested sludge is conducted to a 25,000-gal. daily supply well adjacent to the power-plant building through closed conduits in a pipe gallery. Ventilation of the pipe tunnel is made positive by two exhaust blowers at the operating manholes rising to the surface between each pair of digestion tanks, and these blowers are connected with the light circuit so that an operator in illuminating the pipe tunnel automatically starts ventilation.

Sludge drying

Sludge drying is accomplished on a vacuum-type filter with ferric chloride conditioning, designed to accommodate in an eight-hour shift the average production for a 24-hour period (4 tons dry weight). Thus the unit may be out of service during periods when weather conditions do not encourage the removal of filter cake for fertilizer purposes and until the open storage tank is filled.

The filter cake from the vacuum drum falls upon a 100-ft.-long belt conveyor for discharge to trucks, and the filtrate flows by gravity back to the incoming raw sewage line of the general city plant.

Gas-engine generator set

The gas engine is a 5-cylinder unit driving a 150-kw., 2,300-volt generator automatically synchronized with the local utility power company circuit. It is completely protected by safety devices, so that it is automatically thrown out of service, and a warning gong is rung in the event of overloading, overheating, failure of water pumps, oil circulation, etc. Due to the fact that it operates in parallel with the power company line, it operates continuously at full load, except during periods of heavy infiltration following rainstorms when pumping requirements are materially increased. It has been able to furnish all necessary power for the plant.

Cooling water from the engine is circulated through the radiators of the three heated digestion tanks. An auxiliary gas-fired boiler rides on the circulation line and is automatically controlled by an aquastat so that in the event that the engine is out of service or when there is improper water temperature the boiler goes into service.

Packing-house pretreatment plant

The packing-house pretreatment plant, which is owned and operated by the city, receives the concentrated wastes of the packing company after it has passed through the company grease traps and 40-mesh screens. Outside of the company property line there is an automatically operated lift station equipped with three pumps, 600, 1,200 and 1,800 g.p.m. respectively, and operated against a total dynamic head of 50 ft. These pumps are controlled by a programming switch actuated by a float, which provides instant changing of routine.

This station is on the opposite side of the Cedar River from the disposal plant, and the delivery line is a 14-in. asbestos-cement pipe suspended from a plate-girder railway bridge. As the deflection of these girders under train impact reaches $\frac{3}{4}$ in., the line is supported on coil springs and hangers. Because of the highly variable rate of delivery of packing-house wastes, a circular storage tank, 70 ft. in diameter and 12 ft. deep, rides on this pump discharge line.

Inside the control house, shown in Fig. 5, a standard rate-of-flow controller is located, and although the plant is designed for 1,000-g.p.m. constant rate, flow rates may be varied at will within reasonable limits. Typical operation during high concentration hours is as follows: flow through controller, to grease remover, to primary clarifier, to flash mixer, to flocculator, to secondary clarifier, to effluent well, through service pump to dosing tanks of general city plant. During the hours of lower concentration at night, the clarifiers may be operated in parallel, and the flash mixer, flocculator and chemical dosage may be eliminated.

While the pretreatment plant is not yet in routine operation, preliminary runs indicate a complete removal of objectionable material that would interfere with the continued operation of the trickling filters with a chemical cost of somewhat less than $8 per million gallons treated. The removal of this material by plain sedimentation and chemical precipitation accomplishes a material reduction in B.O.D. Typical results are not available, but preliminary results based on economical dosages

run from 40 to 50 per cent reduction in the 2,000-p.p.m. average B.O.D.

The elevation of this plant is such that delivery of chemicals from tank cars on the near-by railway is through gravity lines laid in vitrified sewer-pipe conduit. The basement of the control building houses four 6,000-gal. chemical storage tanks, two rubber-lined for ferric chloride and two steel for acid.

Under ordinary conditions the storage tank is empty four hours a day, or from 2 to 6 a.m. A flushing pump in the basement draws clarified effluent from the clear well and delivers it to a rotating wash-down device set on a center column in the tank, so that odor-producing material clinging to the walls and floor may be removed.

Gas production under present operating conditions, using sludge from general city sewage only and before the introduction of the packing-house sewage, is averaging 140,000 to 150,000 cu.ft. per day, with a gross B.t.u. of 624 per cu.ft.

Cost and financing

When completed, the entire cost of the treatment installation will approximate $750,000, exclusive of intercepting sewers, river crossings, etc., constructed separately in the past few years at a total cost of $500,000 (*ENR*, July 25, p. 118).

This plant was a PWA project financed by a $202,000 federal grant and a $548,000 four per cent bond issue, the entire cost of operating and financing to be paid by sewer rentals, the general rate being 25 per cent of the water bills with special rates for industries and private water producers. When industrial contributions are deducted from the total cost of operation and financing, the cost is one-fourth of 1c. per capita per day, or $55,000 per year.

Design of the plant was started in September, 1933. The project was divided into ten sections, and contracts were released for award from time to time to fit in with the local re-employment program. The contractors were as follows: main pumping station, Hopp Construction Co., Cedar Rapids; laboratory, Morehead & Fredrickson, Cedar Rapids; power station, clarifiers and packing-house pretreatment plant, Stark Building Co., Cedar Rapids; filters, Bemis & Schlick, Des Moines, Iowa; gas-engine generator set and vacuum filter, Iowa Manufacturing Co., Cedar Rapids; rotary distributors for filters, The Dorr Co., Chicago; electrical contract, Fowler Electric Co., Cedar Rapids; digester covers and gasholders, Pacific Flush Tank Co., Chicago.

The major mechanical items were handled by fixed-sum method whereby the general contractor set up the amount instructed for the purchase of the equipment and added to that amount his bid for installation, profits, etc. At the same time that such bids were received, quotations on mechanical equipment were also received. After the selections were made the general contractor was instructed what equipment to buy, and his contract sum was then adjusted correspondingly. This facilitated matters in that each manufacturer of mechanical equipment made only one direct quotation and did not have to contact all general contract bidders prior to each letting.

This project was designed by Howard R. Green Co., consulting engineers, Cedar Rapids, who, with F. E. Young, city engineer, jointly supervised the construction.

Earthfill Dam to Be Built by Method of Soil-Compaction Control

THE FIRST CONTRACT for a large dam to be built by the Proctor method of soil-compaction control recently was let when the Metropolitan Water District of Southern California authorized construction of the 194-ft. Cajalco Dam, near Riverside, Calif. When plans were drawn there was some apprehension about contracting a job of this type; it was thought that the exactitude of the requirements for obtaining the desired degree of compaction would result in high bids. This apprehension was dispelled when it developed that of the six bids received from responsible contractors five were within the range of $4,647,000 to $4,883,000. Essential features of the Proctor method of building earthfill dams were published in a series of *Engineering News-Record* articles, Aug. 21, Sept. 7, Sept. 21 and Sept. 28, 1933.

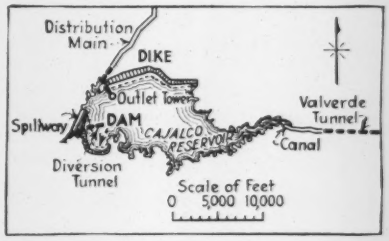


FIG. 1—RELATIONSHIP of dam and dike at Cajalco Reservoir on the Colorado River Aqueduct.

Future raising of the dam by 46 ft. is contemplated in the design. In the ultimate dam the downstream third is to be pervious fill, the upstream two-thirds compacted fill. Almost the entire yardage in the present contract is tightly compacted material, and only a small toe section is pervious fill, as will be seen from Fig. 2, a cross-section showing the present and future outlines of this structure.

Principal items of the present contract are about 7,000,000 cu.yd. of fill and 100,000 cu.yd. of concrete. The price for compacted earthfill was 37c. per cu.yd. on the dam and 44½c. per cu.yd. on the dike. The work is to be completed by Oct. 21, 1938. It is expected that 300 to 350 men will be employed during the construction period.

The reservoir will have an initial capacity of 100,000 acre-ft., which is for use in storing water that has been brought through the 242-mile aqueduct from the Colorado River. Later, when the height is raised to 240 ft., the storage capacity will be 225,000 acre-ft. Cajalco Reservoir is about 60 miles from the center of Los Angeles.

The contract for Cajalco Dam is being carried out by the Griffith Construction Co., of Los Angeles, under the general direction of the Metropolitan Water District of Southern California, of which F. E. Weymouth is chief engineer and general manager.

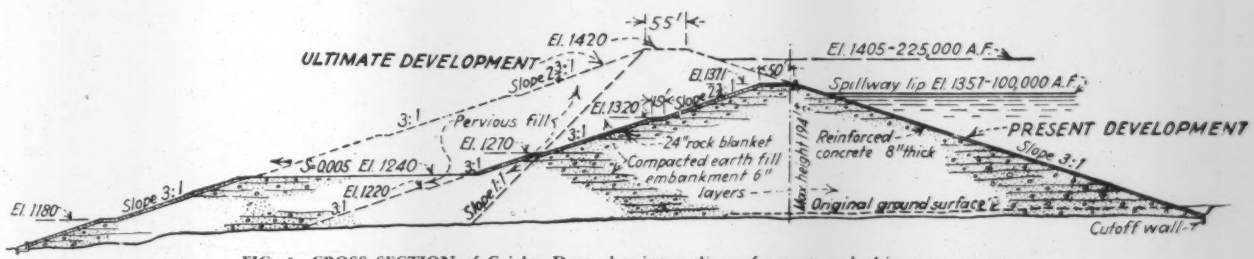


FIG. 2—CROSS SECTION of Cajalco Dam, showing outlines of present and ultimate structures.

Relief Labor Drives Tunnel by the Shield Method

Six-foot storm drain driven 900 ft. through boulder bearing ground at Middletown, N. Y., by relief-labor crews erecting precast concrete-block lining within small shield

FIG. 1—HEADING EXCAVATION within 6-ft. shield, one of the operations in driving a 900-ft. sewer tunnel at Middletown, N. Y., with relief labor.

A WORKS-RELIEF PROJECT recently completed at Middletown, N. Y., involved the building of a storm-drain tunnel 900 ft. long and 30 ft. below the surface through ground of varying formation but filled with small boulders. The Emergency Relief Bureau officials in charge of the project desired a maximum of employment on the work. Open-cut methods were considered too expensive, especially as the drain paralleled the main line of the Erie Railroad, requiring heavy and carefully placed shoring. After considering the hazards of using inexperienced relief labor in normal tunneling methods, in which heavy timbering would have been required, those in charge selected the shield method as safest and cheapest. In the method selected a permanent lining was provided by erecting rings of precast trapezoidal blocks within the shield, giving instant and safe support of the ground and full protection to the workmen.

The shield and tunneling process involved are similar to those used in driving a 4-ft. tunnel underneath the Pennsylvania Railroad tracks at Norristown, Pa., described in *ENR*, Aug. 10, 1933, p. 162, except that the Middletown job marks the first use of this type of shield on a 6-ft. bore. In good ground a progress of 2 ft. per hour was maintained, but much of the time the shield advance was slowed to be less than 1 ft. per hour because of the blasting required to remove boulders from the heading. Excavation averaged 1.49 cu.yd. per foot of tunnel.

Each ring of the lining is made up of 24 precast interlocking concrete blocks, trapezoidal in shape and weighing about 63 lb. per segment. All blocks were made on the job in a hydraulic hand press. Half of the blocks, known as pushers because they bear the brunt of the shield jacks, are made with tongues on two sides and on the wide end, and a groove on the narrow end; the other half, known as fillers, have corresponding grooves on three sides and a tongue on the shorter fifth side. The tongues and grooves of adjacent blocks interlock in a bed of asphalt applied to the contact surfaces prior to erection of lining. A corrugated groove is cast along two edges of the inner face of each block to provide a wide crack for pointing the inside surface of the lining to make watertight joints.

Blocks were made with a 1:1.8:2.2 mix, the coarse aggregate being ¾-in. gravel. Desired compressive strengths were 2,500 lb. at 7 days and 3,500 lb. at 28 days. Actual tests indicated an average compressive strength of 4,815 lb. at 28 days. Two shifts per day of six men each manufactured the blocks. From a small hand-charged mixer concrete was shoveled into the block press, where a few strokes of a hydraulic jack handle were sufficient to compress the concrete into block form. After a few days' curing the contact faces of the blocks were covered by a dipping process with asphalt heated to 155 deg., five men being used for this work. The finished blocks were stored near the portal.

Shield of novel design

The small shield consists of an articulated shell 10 ft. 1½ in. long, with a 2-in. overhang on the cutting edge. Two full sections of the shell are jointed at the center by four bolts at the quarter points, which provide directional control if needed in addition to the control possible through the shoving jacks. Jacking equipment consisted of two alternate banks of twelve double-cylinder hydraulic jacks equally spaced in the tail

FIG. 2—PRECAST CONCRETE BLOCKS of trapezoidal form interlock into smooth rings of tunnel lining, erected within the shield. Alternate blocks, called pushers, take the main thrust of the shield jacks. Grooves are cast along certain edges to form recesses for pointing the joints between blocks after the lining is erected.

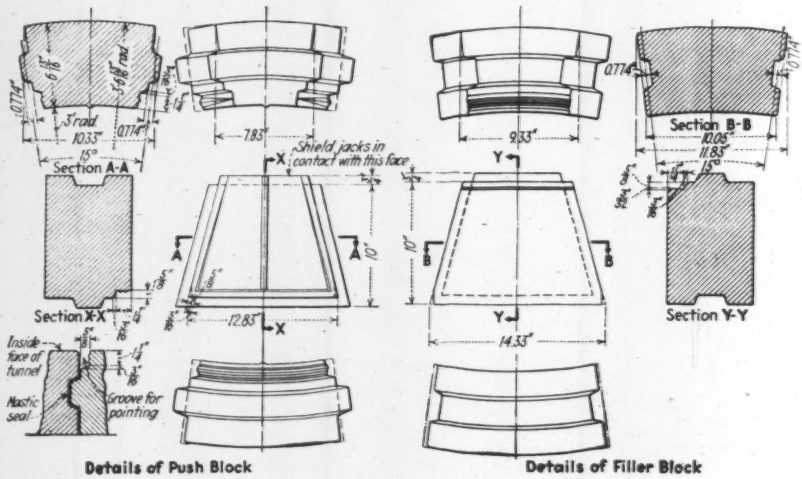


FIG. 3—OPERATING EQUIPMENT of the 6-ft. shield includes 24 shoving jacks, and a narrow belt conveyor for transportation of spoil through the shield. In this view of the jacks the alternate bank of jacks bearing on the filler blocks is extended to keep the shield from floating while the next set of alternate shoving blocks, for which the jacks have been retracted, is being placed. Excavated muck is thrown into the hopper at the foot of the conveyor and is discharged at the far end into a car for disposal.

of the shield. The two concentric cylinders of each jack, 4 and 3 in. in diameter, were hooked up to high and low-pressure lines, respectively; the high-pressure cylinder was used for shoving, the other merely held the blocks in place until the ring was completed. Normally, only one bank of jacks (those bearing on the alternately-placed shoving blocks) was used for propelling the shield (Fig. 3). Oil in a closed circuit was used as the hydraulic medium, the pressure being produced by compressed air from a portable compressor outside the tunnel.

For handling muck through the shield an inclined belt conveyor extending into the front compartment discharged behind the shield directly into a small narrow-gage car. The conveyor assembly was independent of the shield and was dragged along on its own track. The muck car, of 21-cu-ft. capacity, had a forward platform upon which blocks were conveyed to the shield (Fig. 4), so designed that the load of blocks extended under the rear end of the conveyor, permitting unloading while the car was being filled with muck.

Driving procedure

Tunnel driving was carried on in three six-hour shifts working five days a week. Each shift consisted of a shield operator, who acted as foreman, two miners, one block setter, two car pushers and two dump men.

The first operation was to build a concrete and steel ring and cradle at the portal from which to start the shield. This consisted of a 7-ft. diameter steel channel ring tied and braced to a concrete cradle by rods. Next to the steel channel a ring of concrete 20 in. wide was built to provide a firm bearing for the shield jacks in starting.

There was room in the heading for two miners to work, casting the muck onto the lower apron of the conveyor with a short-handled shovel. While the nature of the ground varied, much of the digging was hard, requiring considerable drilling and blasting. Boulders caused trouble; those of large size had to be broken up by blasting to permit handling through the shield. Some water was encountered, but not enough to cause any trouble. As a measure of precaution, the heading face was breasted and shored when the shield was in soft ground and during the two-day week-end periods.

The shield advanced 10 in. per shove. Following a shove, a ring of blocks was erected as the mucking out proceeded, neither operation interfering with the other. At the start of block erection, all of the jacks were in the retracted position. The alternate shoving blocks, with narrow end forward, were set first, the low-pressure cylinder of the corresponding jack being extended to hold the blocks in place as they were set. Once the shoving blocks were set, the filler segments were placed in rapid order and held by the corresponding low-pressure jacks.

Muck cars were pushed in and out of the tunnel by hand. Final disposal of muck was by dumping into another car, which was hauled to a near-by dump by a hand-operated hoist.

The tunnel was built at a cost of $38 per foot, including all labor, materials and rental of the shield, block-making equipment, mixer and compressor. The project was under the direction of R. Knight, executive director of the Emergency Relief Bureau, and J. F. Gates, director of public works of Middletown. R. F. Ballard was engineering representative of the city, and John Neamand was general foreman. The shield was built and furnished by the Link-Belt Co., of Philadelphia, now associated with the Tunnel Mine & Machinery Co., holders of patents on the shield and block design.

FIG. 4—SPECIAL CAR for handling muck and blocks is equipped with a low deck upon which blocks are carried into the tunnel. Blocks are unloaded while the car is being filled from the shield belt conveyor.

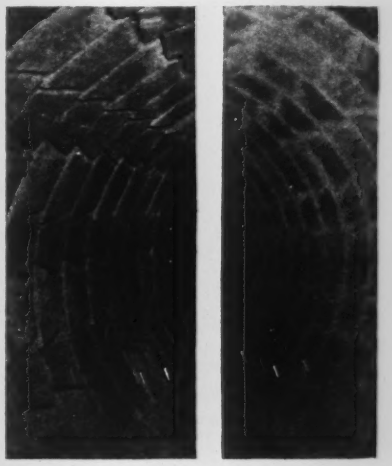


FIG. 5—FINAL STEP in building the tunnel is pointing of the joints with cement mortar to provide a watertight lining. Views of unpointed and pointed sections are shown here.

Fort Peck Dredges Designed for High Capacity on Long Pipe Lines

Pumping plant for placement of huge earthfill, built and assembled at the dam, consists of four identical units of one dredge, one floating booster and one rail-mounted booster, all equipped with 28-in. electric-drive pumps

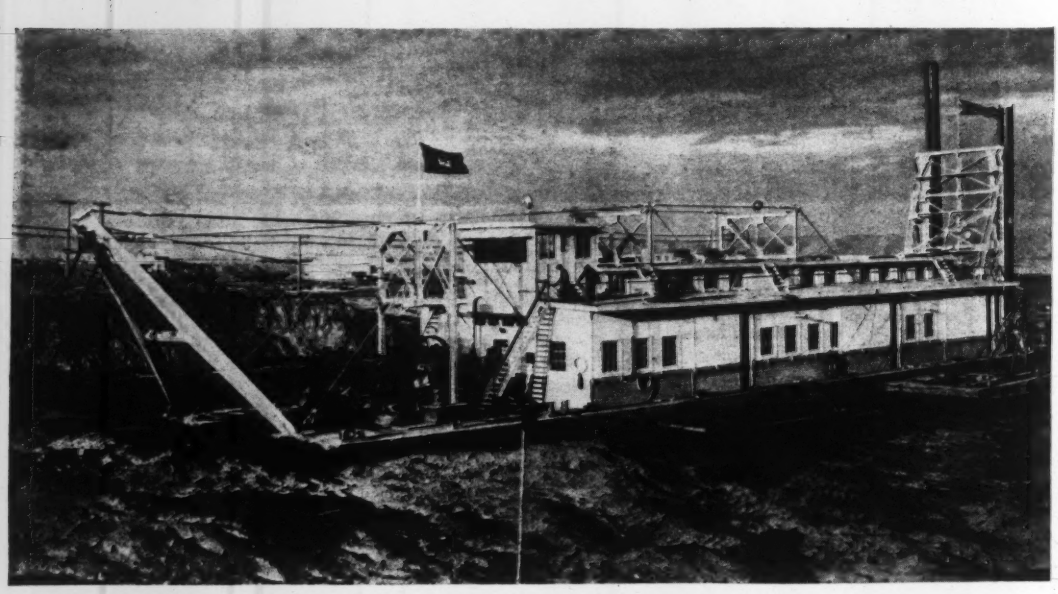


FIG. 1—MONTANA'S LONE SHIPYARD produced four of these dredges and most of the accessory floating plant required for the Fort Peck Dam. Each dredge is equipped with two 28-in. pumps having 78-in. diameter impellers.

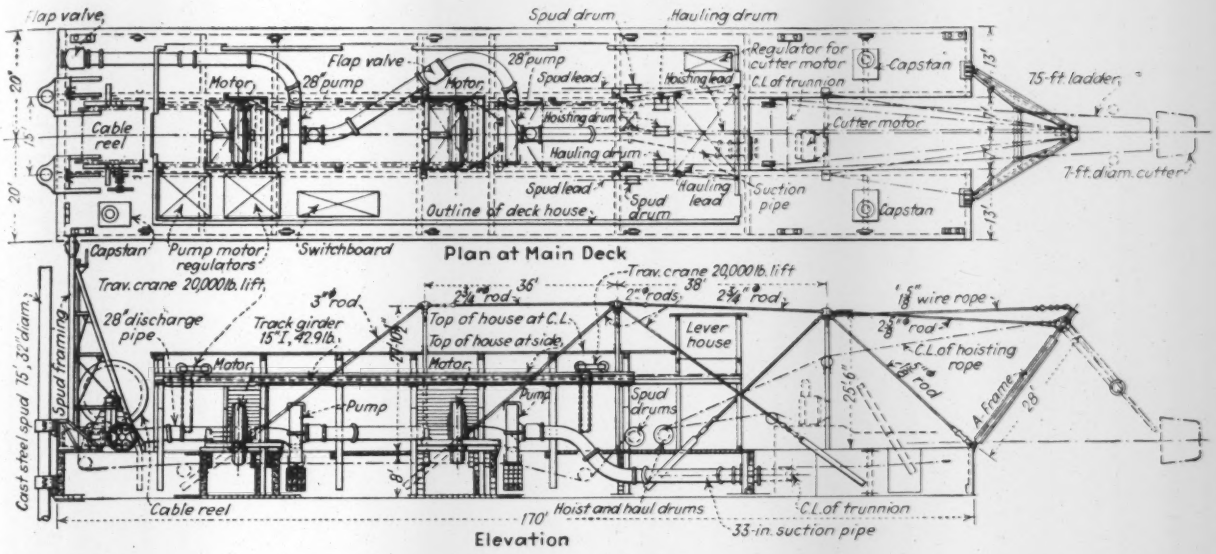
THE successful creation of the huge 100,000,000-cu.yd. hydraulically placed earthfill for the Fort Peck Dam depended upon two major items—the availability of suitable materials and the design of a plant capable of placing those materials economically at a daily yardage rate never before attempted in earth moving. Investigations revealed the presence of ample quantities of suitable materials. The next step was to design a dredging plant capable of transporting the materials up to a distance of 17,000 ft. and up to 240 ft. in elevation.

The unusually long pipe lines, the high heads to be pumped against, the need of utmost flexibility of operations, and the vast quantities of materials to be moved were all special problems that had to be considered. Attention was also given the character, specific gravity, abrasiveness and frictional resistance of the material and the line of saturation and capillary attraction of the fill in the dam. To meet these special problems, the army engineers concluded that a special dredging plant was required, resulting in a design of equipment that departed from the conventional in several respects. First of all, a filling schedule of 3,000,000 cu.yd. per month was determined necessary to complete the dam in the desired time. The number and size of units required to meet this schedule was the next consideration.

After carefully considering a greater number of smaller units, the designers finally selected four 28-in. units as offering the most economical arrangement. The dredging and pipe-line layouts were described in a previous article (*ENR*, Aug. 29, 1935, p. 292). Four units fitted best into the scheme of building the dam in two sections in the early stages, and offered a suitable plant for continuation of filling when the river is closed and operations are carried on over the full length of the dam. The 28-in. pipe lines are much larger than is usual for this type of work and represent a heavy investment. They are also much heavier to handle than a smaller size would have been. Yet the long stretches of land between borrowpits and dam offered a chance for semi-permanent installations of long land lines. These large-diameter lines also resist wear to a greater extent than do the smaller lines. Heavy equipment is required to build up the levees on the outside of the beaches and to trim the slopes, and with this equipment available at all times handling of the heavy pipe at the dam is made simple and easy.

Design of dredges

Each of the four dredging units consists of one dredge with two 28-in. pumps set in tandem, each driven by a 2,500-hp. electric motor, one floating booster plant with two 28-in. pumps, also set in tandem, and one land booster mounted on railroad car trucks, with one 28-in. pump. All pumps and motors and even the accessory plant on each unit are identical and interchangeable with that on other units. For each of the twenty large pumps duplicate parts are kept on hand making a total of 40 complete pumping units in all. The combined motor and pump effi-



ciency of the five pumps in series, when pumping through long pipe lines and against high heads, is rated at 60 per cent.

The dredges and floating boosters are identical in design, except of course, that the boosters have no cutting machinery or spuds. Equipment of each land booster is identical with half that of a floating booster.

The dredges consist of a wooden hull 170 ft. long, 40 ft. wide and 8 ft. deep, divided into wells by cross and longitudinal wooden bulkheads. A light wood housing covers most of the barge, and the operator's house is set high on the front end. Rigidity of the dredge structure is provided by a system of steel posts and hog rods. Two 10-ton hand-operated overhead traveling cranes operate on 15-in. track girders for handling of the heavy parts when repairs are necessary.

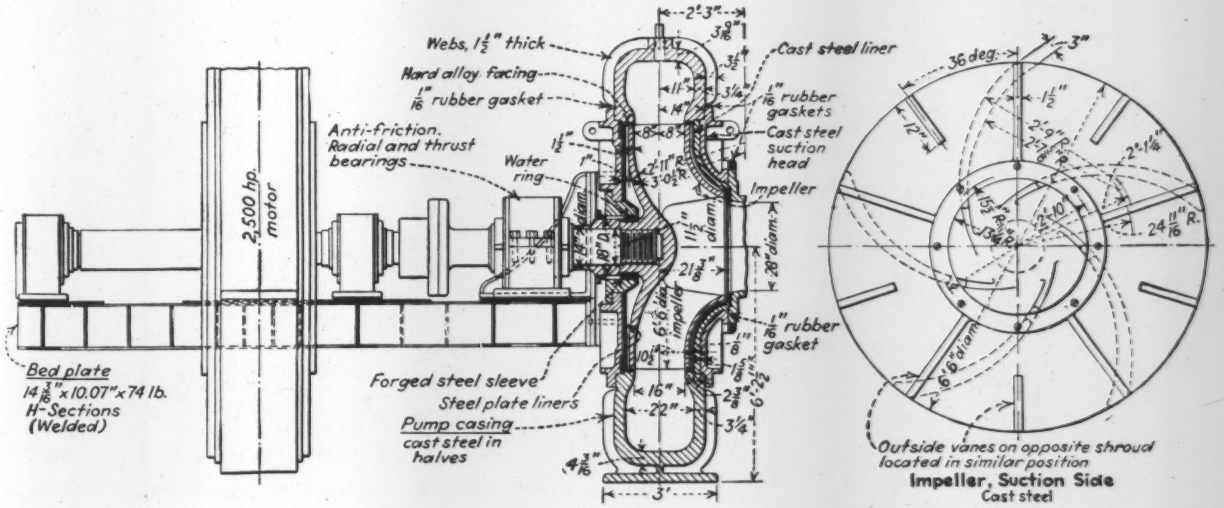
A 7-ft.-diameter cutting head, 6 ft. long, rides on the end of a 75-ft. ladder, which is handled by fall lines from a 28-ft. steel A-frame. The cutter is driven by a 700-hp. electric motor connected to the cutter shaft through a series of reduction gears. At first the suction pipe between cutter and pump was 28-in. in diameter, the same size as the discharge lines. Later this was changed to a 33-in. line, which has proved more successful in maintaining the proper vacuum. Fig. 2 shows the general layout of the equipment in the dredges.

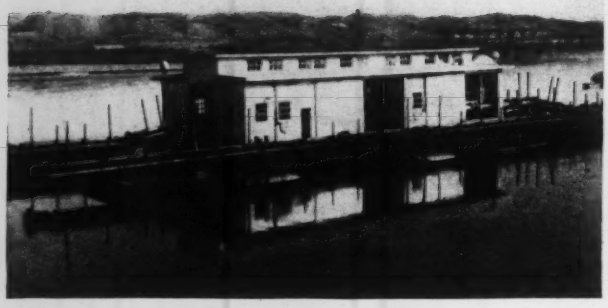
FIG. 2—RANKING with the largest ever built, the Fort Peck dredges depart from conventional design in that two 28-in. pumps are set in tandem at the same elevation. Direct-connected 2,500-hp. induction motors with wound rotors for variable speed drive the pumps.

The two pumps, set in tandem 40 ft. apart, have cast-steel runners, 78 in. in diameter, and semi-steel shells, split horizontally, with high-carbon steel liners (Fig. 5). They are direct-connected to 2,500-hp. three-phase induction motors running at speeds from 150 to 250 r.p.m. Power is supplied to the motors at 6,600 volts. Each motor requires about 1,800 kw. when running wide open. In normal operations each pump boosts the pressure in the pipe lines about 60 lb. per sq.in. The pipe lines are designed to withstand a pressure of 700 lb. per sq.in.

To reduce wear in the shells and runners, service water is pumped into the casings at high pressure. The materials being pumped are highly abrasive, necessitating frequent changes of pump parts; though the various parts were made much heavier than usual to allow for considerable wear without danger of breakage under the high pumping pressures or loss of efficiency. Liner plates usually last about two weeks, shells about one

FIG. 3—DETAILS of the 28-in. pumps. The cast-steel impellers are 78 in. in diameter; the shells are over 12 ft. in diameter. All parts are extra heavy to resist the highly abrasive action of the river deposits containing volcanic ash.





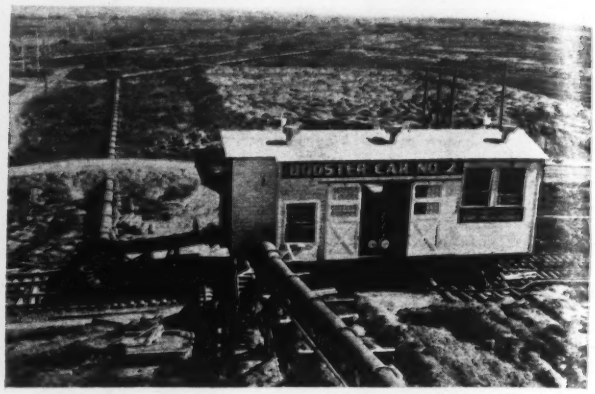


FIG. 4—BOOSTER PLANTS on land and water aid in moving the material the three miles from the dredges to the dam. Two 28-in. pumps are installed on the floating booster, one on the land booster.

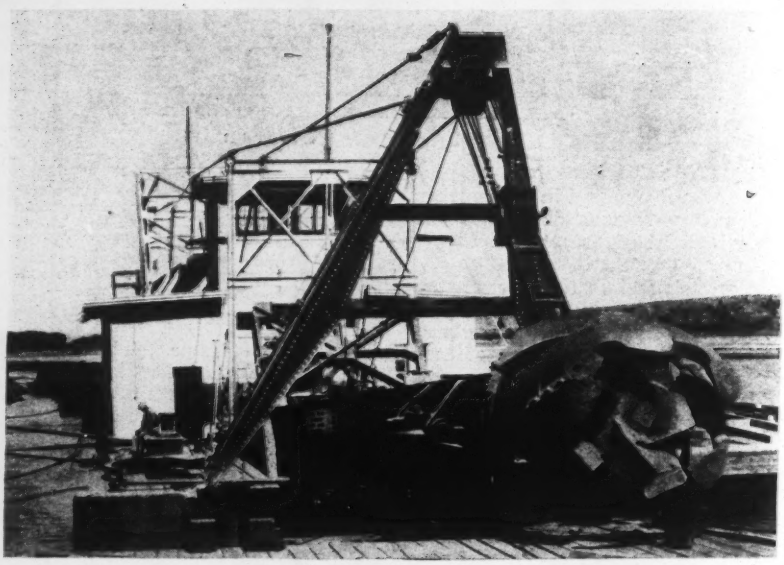


FIG. 5—BASKET-TYPE CUTTERS, 7 ft. in diameter, are used on the dredges as most suitable for soft ground digging.

month and runners about 60 days of continuous operation before requiring replacement. These parts are not completely worn out in this time and are easily restored to serviceable condition after building them up by welding in a shop that is part of the plant.

In operation, the two pumps act as one unit, and as high a vacuum as possible (about 24 in.) is maintained on the suction line. Flap check valves located on the pressure side of each pump prevent backwash when the pumps are shut down. Occasionally the vacuum breaks, and an operator is kept at the pump switchboard to slow down the pumps until the suction is caught again.

While the motors are of the variable-speed, wound-rotor type, they are set at a certain desired speed, which can be readily changed. At the set speed, they operate at constant torque through an electrolyte solution rheostat. A special pump circulates the electrolyte solution and cooling water to keep the regulator cool.

Each dredge is equipped with two 32-in. round cast-steel spuds 75 ft. long, attached to the rear of the hull 15 ft. apart. They are handled by lines running over steel towers erected on the deck. Between the spud frames is located the feed-cable reel, 11 ft. in diameter, hand-powered. This cable reel can take 700 ft. of 3-in. conductor cable, which is carried from land to the dredge on light pontoons.

Power for operating the ladder hoist line, the haulage lines for swinging the dredge and the spud lines is provided by a single electric motor operating the various hoist drums through friction clutches. All hoists are controlled through levers from the operating cabin.

All floating pipe line is of the flexible steel ball joint type. To make the connections between land and floating lines, special landing barges are used. These barges hold three lengths of pipe with ball joints, suspended from A-frames by chain hoists. After being connected into the discharge lines, the chain hoists are cut loose and the pipe sections rest in cradles.

Land boosters

The land boosters, containing only a single pump, are mounted on four railroad trucks operating on a standard-gage double track, which is laid parallel to the upstream toe of the dam. Equipment is similar to that of the dredges and floating boosters. The pump is suspended at one end of the car; the pipe lines do not pass through the car. The cars are self-propelling through an electric hoist and cable arrangement.

These units are seldom moved, and, once spotted, they are braced by threaded-rod anchor arms fastened to deadmen buried alongside the tracks. These anchors and the setting of the track ties on concrete sills reduce vibration in the car units to a minimum. The car boosters were erected on the river bank near the dam. Special car ferries have been built to transfer these units across the river when required.

All of the floating equipment, except seven 100-hp. gasoline launches and one 210-hp. towboat, was built by government day labor at the boatyard downstream from the dam. This plant simply had to be built and assembled at the site, for no other course was possible. The units are too large for transportation by rail, and uncertain navigability of the Missouri River to the site precluded construction in downstream boatyards and floating to the work.

Being of special design, the machnical and electrical equipment was furnished under competitive bidding contracts by numerous firms, requiring assembling and erection at the job by the government. Regular launching ways were provided for the building of the dredges and floating boosters. The multitude of pipe and cable pontoons were built bottom side up on the bank and were thrown into the water by cranes.

The boatyard was the scene of great activity during all of last year. A considerable amount of employment was furnished local workers during the early stages of the Fort Peck project

by building the floating plant at the site. About the only classes of labor necessary to import from outside the state were calkers, shipwrights and riggers. The amount of boat building done in Montana prior to Fort Peck trained very few shipbuilders.

Successful operation

The dredging plant has performed to all expectations in placing the first 20,000,000 cu.yd. of fill in the dam at an average rate of 3,300,000 cu.yd. per month. While many features of the design of the plant are new and unconventional, the fact that the required schedule is being surpassed marks the plant as successful. Minor changes are constantly being made to better operations, but in general the plant stands as originally designed.

The dredging plant was planned by Col. C. W. Sturtevant, of the Missouri River Division office, Kansas City, Mo., and Wm. Gerig, head engineer, office of Chief of Engineers, Washington. Detail plans for the dredge hulls, pontoons, boosters and other floating plant were made under the direction of Colonel Sturtevant. The pumps and other machinery were designed under the supervision of Mr. Gerig. D. B. Botkin was in charge of operations at the boatyard. Major T. B. Larkin, District Engineer, is in charge of the Fort Peck project.

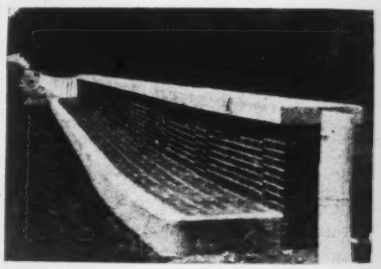
Brick Facing Applied to New Hampshire Highway Bridge

By E. F. Gallagher

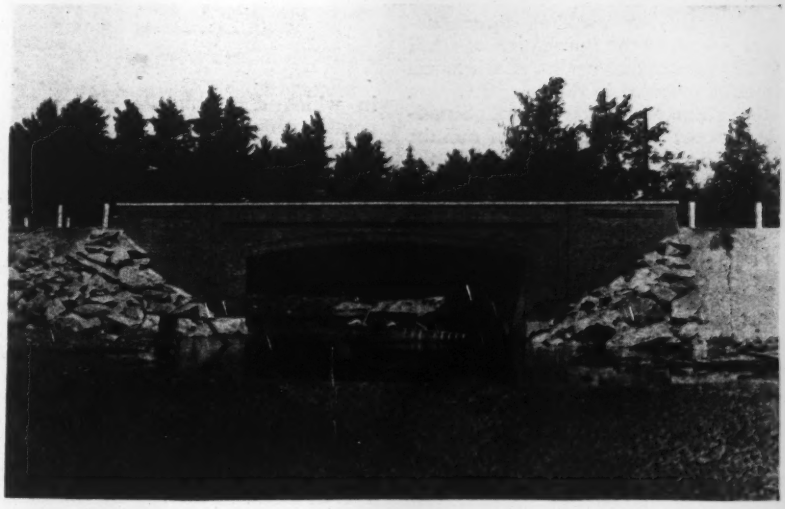
Manager-Engineer, New England District, Brick Manufacturers Association of America, Worcester, Mass.

A CONCRETE HIGHWAY BRIDGE with a brick veneer finish has been erected near Epping, brick-manufacturing center of New Hampshire. The bridge is located on one of the main cross-state highways, route 101 from Portsmouth to Keene, and spans the Lamprey River. Of rigid-frame type the bridge has a span of 38 ft. 8 in. and is on a 26½-deg. skew. It has a 24-ft. roadway and brick sidewalks 2 ft. 8 in. wide. The guardrails, of brick veneer on reinforced concrete, are 1 ft. 3 in. minimum thickness, set with the top 2 ft. 7 in. above the level of the brick-paved sidewalk and 3 ft. 4 in. above the road level at the gutter line.

The materials used in the structure meet the standards of the New Hampshire highway department. The brick is of waterstruck manufacture, locally made and selected for uniform color. Mortar below grade and high-water levels is of a 1:2 cement-sand mix; elsewhere it is a 1:1.5:3 mix of cement, lime and sand. The granite curbing and coping is of a light shade of locally quarried granite.



BRICK VENEER used for architectural treatment of a bridge over the Lamprey River, West Epping, N. H.



The architectural treatment of the bridge, based on the use of waterstruck brick, took into consideration their size, which is somewhat smaller than standard. Resting on shelves built on the concrete near the footings, the brick veneer is anchored by the use of heavy copper ties placed 18 in. on centers horizontally and every fourth course vertically. A running bond was used except in the corbelling of the panels in the wingwalls, the arch of the bridge, and the corbelling at the road level. The exposed joints were tooled after the mortar had partly set, insuring complete bond between brick and mortar at the weather edge.

The arch, with its center about 2 ft. above the level of the springline at the abutments, is given the appearance of a natural brick arch by using two courses of soldiers and one of headers. Directly above the top of this arch treatment and at the roadway level, the veneer is corbelled out 2 in. in four courses to accommodate another soldier course, which was in turn used as the base for the wall treatment. The wall treatment consists of panels 4 ft. wide between 16-in. piers set out ½ in. The tops of the panels are set off with another soldier course which supports the granite coping. The inside face of the wall is treated similarly, above the level of the sidewalk. The sidewalks are laid on fill built up from the rough top of the concrete structure. A ½-in. bed of mortar was used on the fill, and the brick was laid in a basket-weave bond, level with the top of the granite curbing.

The contract price on the brick veneer in place was $70 per 1,000, or about 42c. per sq.ft. of wall area.

The bridge was built by the Lane Construction Co., New Haven, Conn. The work was done under the direction of H. E. Everett, commissioner of highways, D. H. Dickinson, chief engineer; John Childs, bridge engineer, with H. E. Langley in charge of design. Clayton Chase was resident engineer for the state.

Highway Construction Bonds for Mexico's 6-Year Plan

President Lazaro Cardenas, of Mexico, has ordered the issuance of $2,800,000 worth of bonds to finance highway construction and kindred works to the end of the six-year plan in 1940. Funds derived from the sale of these securities will augment those obtained from the floating of an issue of $5,600,000 of road bonds last year, and will enable the federal government to pay highway contractors in cash, instead of issuing them credit certificates. The President explained that the credit certificate system was not altogether successful as it slowed down road works.

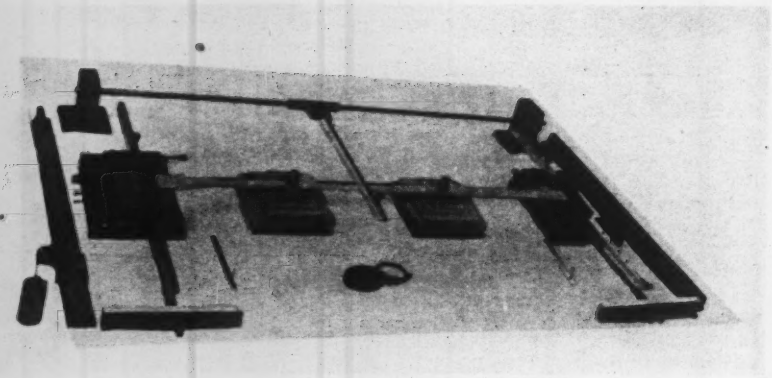


FIG. 1—APPARATUS with cardboard model of a frame member in place. Gages clamping model provide for rotating the ends of the model or displacing them relative to one another. Constants are deduced directly from scale readings.

Fixed-End Moments by Cardboard Models

New apparatus and procedure furnish simple means of determining elastic constants for Cross method of indeterminate structure analysis

By William J. Eney
Baltimore, Md.

A COMPLETE ANALYSIS of a statically indeterminate structure, involving dissymmetry of form or loading by the Hardy Cross method of distributing fixed-end moments, requires the determination of several elastic constants and moment coefficients for each member of the structure; certain of these are obtainable from charts but frequently are laboriously computed. These constants and coefficients may be determined by testing elastic models with an apparatus developed by the writer and recently delivered to several universities for use in graduate studies. Although the use of models in structural analysis is not new, this apparatus in its entirety, and most of the method, are believed to be original.

In the accompanying photograph of the apparatus (Fig. 1) a simple cardboard model of a member of a structure is shown clamped at its ends to two gages, and at intermediate points supported on steel balls and weighted with small weights to give lateral rigidity without friction. The gages are adjustable along a fixed aligning bar, to fit any length of model up to 48 in. With these gages, the ends of the model can be rotated either by weights or thumb screws, or displaced definite amounts with respect to each other. A pointer set 10 in. from the rotation center measures the gage rotation on self-contained scales. The deflection of the axis of the model, caused by rotating its ends, is measured by a scale sliding on a fixed bar. All scales are graduated 100 divisions to the inch and are easily read with a magnifying glass. The elastic constants and coefficients are deduced directly from the scale readings. The apparatus is also designed for use in other types of model analysis which are beyond the scope of this article.

Cardboard models

A good quality sheet cardboard $\frac{1}{8}$ in. thick is used as model material; although not as homogeneous as celluloid, it is more easily cut out. Large-scale models are used, thereby avoiding the refinements attending the fabrication of small models to exact dimensions. Each model should be oriented in the same direction of the grain of the cardboard. Similitude between the actual member and the model is accomplished by making the widths of the model proportional to the cube roots of the moments of inertia of the member at corresponding sections. The length or widths of the models of a frame need not be to the same scales.

To illustrate the use of the apparatus to determine elastic constants, the testing of a cardboard model of member A of the hypothetical frame shown in Fig. 2 will be described; members B and C were also tested with the same accuracy as is indicated for member A. Reference is later made to a constant-section calibration model representing a member 30 ft. long and of constant I of 12 ft.[4] All models were 30 in. long, being of different length scales, but were all the same width scale—1 in. represent[ing] an I of 8 ft.[4] In laying them out the g[ag]e axes of their prototypes were as[sum]ed to be straight lines, to afford a more direct comparison with the theoretical values. When testing a model, the constants are not determined in the order in which they will be described, but rather by working at one end of the model at a time, taking the few readings required at that end for all of the constants and coefficients.

Load-moment coefficients

Referring to Fig. 3, the fixed-end moment coefficients at the end of a member are found by rotating that end of its model to any unit rotation (d_1), holding the opposite end fixed and measuring the deflections of the axis of the model (d_2) at points where loads will be applied to the actual structure and parallel to the line of action of those loads. With one setting of a gage, the deflections of all load points are measured. From Maxwell's law it follows that the fixed-end moment

$$\text{F.E.M.} = \frac{d_2}{d_1} \times \text{scale of model} \times \text{load.}$$

As shown in Fig. 3 for a unit load at point 7, the F.E.M. at the small end of member A equals 5.05 ft.-lb. compared with a theoretical value of 5.24 ft.-lb.

Stiffness factor

Referring to Fig. 4, the stiffness factor of an end of a member is obtained by measuring the rotation of that end of its model when a torque is applied by means of a weight hung to the graduated arm of the gage, while the opposite end of the model is held fixed. For all models cut from the same sheet of cardboard, and tested with the same torque units, the stiffness factor S is

$$S = \frac{1}{d_2 \times R_L} \times (R_S)^3$$

in which d_2 = deflection of gage-arm pointer per unit torque; R_L = ratio of length of model (scale 1 in. = 1 ft.) to the actual length of model as tested; and R_S = ratio of width of model (using an adopted standard scale) to the actual width of model as tested. R_S generally equals unity, as models are usually to same width scale.

Fig. 4 shows the stiffness of the large end of member A to be 45.5 in. torque units. The calibration model has a stiffness of 58.1 in torque units, and an I/L of 0.400, so that the I/L stiffness of the large end of member A is $\frac{45.5}{58.1} \times 0.400 = 0.314$ compared with a theoretical I/L of 0.317. Generally the stiffness in

torque units is just as conveniently used, so that the calibration model seldom need be employed for this purpose.

Carry-over factor

The carry-over factor of an end of a member is found by applying a torque to that end of the model and ascertaining the restraining torque needed to keep the opposite end fixed. The ratio of the restraining torque to the applied torque is the carry-over factor. Actually, no torques need be applied to the model, since the rotation per torque of 1 in. W for each end of the model was measured when finding the stiffness factor. Consequently, as shown in Fig. 5 for member A, the large end of the model was rotated a convenient amount, the subsequent free rotation of the small end recorded, and from these two readings the equivalent torques were deduced. The scales of the model do not affect these factors.

Displacement moments

When the fixed-end moments for a frame such as is shown are distributed, almost any type of loading will cause sideway. The distributed moments consequently will need correction if translation can take place. When making this correction, member A is temporarily considered rigid, the footings and joints fixed, and the F.E.M.'s in members B and C for a sidewise displacement of the top of the frame are found. With the frame in this displaced position, the joints are released, the displacement moments distributed, the shears computed and the sidesway moments proportioned. In this problem the amount of displacement is generally of no importance, and the F.E.M.'s need only be relatively correct for the displacement involved.

For estimating stresses due to change of temperature, shrinkage, settlement of foundations, etc., similar displacement moments are needed; but they must be consistent with the definite displacements involved in the actual structure.

For all these latter problems, these displacement moments are obtained at one time with models by measuring the torques required to keep the ends of the models fixed-ended while their ends are displaced with respect to each other. The gages permit displacements up to 1.000 in. in steps of 0.250 in. In this case, as with the carry-over factors, the torques need not be again applied but, as shown in Fig. 6, are deduced from the stiffness factor reading. When the small end of model A was restrained against rotation and displaced 0.250 in. in opposite directions from the normal position, the large end freely rotated 0.258 in., from which it is deduced that a torque of 11.7 in. is required to keep that end fixed-ended.

For sidesway correction, F.E.M.s

FIGS. 2-7—OPERATIONS of apparatus and calculating procedure for determining fixed-end load and displacement moments, stiffness factors and carry-over factors.

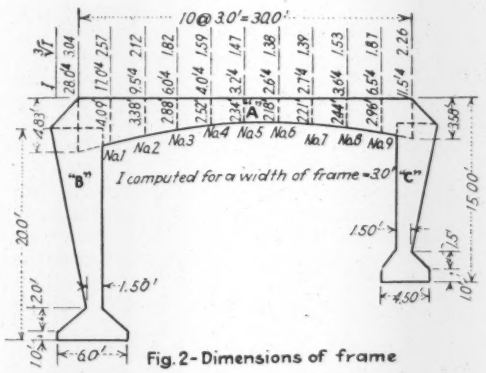


Fig. 2- Dimensions of frame

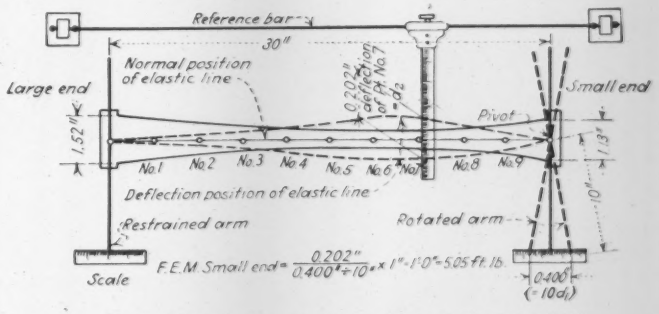


Fig. 3- Fixed end moment at small end of member "A"

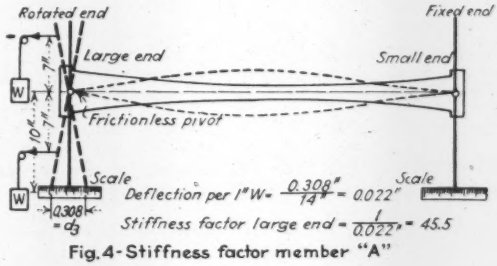


Fig. 4- Stiffness factor member "A"

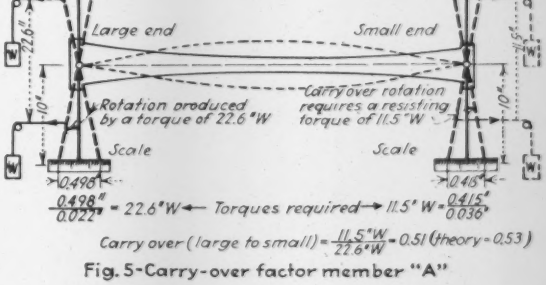

Large end
Small end
Rotation produced by a torque of 22.6"W
Carry over rotation requires a resisting torque of 11.5"W
Scale
Scale
0.498"
0.415"
0.498" / 0.022" = 22.6"W ← Torques required → 11.5"W = 0.415" / 0.036"
Carry over (large to small) = 11.5"W / 22.6"W = 0.51 (theory = 0.53)

Fig. 5- Carry-over factor member "A"

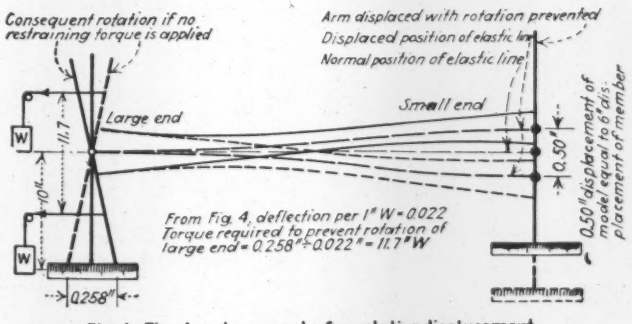

Consequent rotation if no restraining torque is applied
Arm displaced with rotation prevented
Displaced position of elastic line
Normal position of elastic line
Large end
Small end
From Fig. 4, deflection per 1" W = 0.022
Torque required to prevent rotation of large end = 0.258" ÷ 0.022" = 11.7"W
0.50" displacement of model equal to 6" displacement of member
0.258"

Fig. 6- Fixed end moments for relative displacement of ends of member "A"

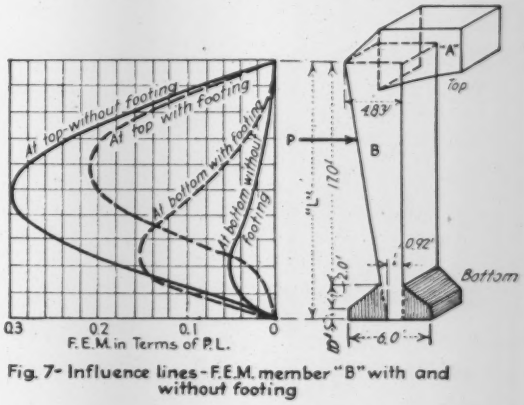


Fig. 7- Influence lines - F.E.M. member "B" with and without footing

COMPARISON OF ELASTIC CONSTANTS TO SHOW EFFECT OF FOOTING

Elastic Constants—Member *B*	With Footing		Without Footing	
	Model	Theory	Model	Theory
Stiffness factor at top	0.71	0.68	0.49	0.485
Stiffness factor at bottom (footing)	0.20	0.20	0.033	0.036
Carry-over factor footing to top	1.28	1.26	1.84	1.82
Carry-over factor top to footing	0.352	0.366	0.121	0.126
F.E.M. for a $\frac{1}{8}$-in. relative displacement of ends of member (in kip ft.)				
At top	578	576	334	322
At bottom	270	277	535	56

consistent with displacement torques similarly obtained for members *B* and *C* can now be assumed. However, when definite displacements are involved, these torque units must be expressed in terms of the absolute moment in ft.-lb. in the following manner: the F.E.M. in the calibration model for a 0.500-in. displacement corresponding to a 6-in. displacement in its prototype was found to be 14.2 in. *W*.

The absolute moment for a $\frac{1}{8}$-in. displacement in the calibration member is 240,000 ft.-lb., which is based on $E = 2{,}000{,}000$; therefore the experimental absolute moment at the small end of member *A* for a $\frac{1}{8}$-in. displacement is $\frac{11.7}{14.2} \times 240{,}000$ ft.-lb. = 198,000 ft.-lb., agreeing with the theoretical value.

The same calibration model will serve perfectly well for as many structures as are cut from the sheet of cardboard.

Members with elastic-riveted connections, haunches, varying cross-sections, wide supports, etc., are easily represented with the model. Studies of the effect of such features as these upon the constants and coefficients can be quickly made by progressively altering the shape of a model to fit each condition. For example, the model of member *B* was altered to eliminate that part of the footing shown shaded in Fig. 7. The elastic constants and moment coefficients as shown in the accompanying table and Fig. 7, were again determined, showing clearly the effect of the footing. Whether the footing acts integrally with this member or not as well as the uncertainties as to its true *I* values are debatable points but should be considered in any complete analysis.

The writer wishes to express his appreciation for the interest that Prof. J. T. Thompson, of Johns Hopkins University, has shown in this apparatus.

Rocker and Suspender Supports for Large Water Pipes at Tacoma

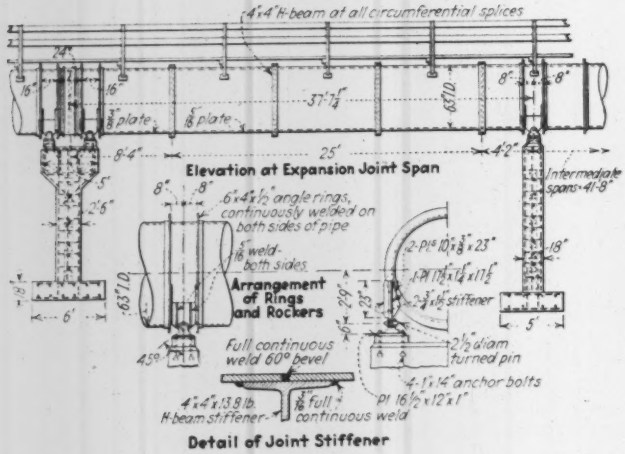
LARGE steel pipes that deliver water to the city of Tacoma, Wash., must cross streams where the pipe is exposed and hence subject to considerable temperature range with consequent expansion and contraction. Provision for the resultant movement has been made by two methods: (1) Suspender bars that sling the pipe beneath an overhead bridge; and (2) rocker arms that transmit the load to concrete piers between which the pipe is self-supporting. Details of both these connections were worked out to give free and unrestricted movement of the pipe as temperature changes occur and at the same time to leave the pipe entirely accessible for maintenance.

The first of these methods is employed where a 60-in. pipe is carried by a steel truss across Green River. Here the pipe is slung beneath the cross-girders by pin-connected, adjustable suspenders consisting of $\frac{5}{8}$x2-in. I-bars with $1\frac{7}{8}$-in. pins at top and bottom. Exact adjustment is provided for by lock-nuts at the lower ends of the I-bars where connection is made between the suspender and the bracket which transfers the load to stiffening rings encircling the pipe.

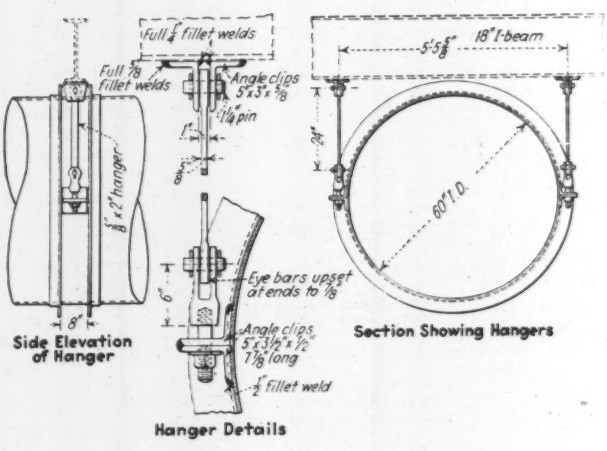
The second method is employed at a crossing where a 63-in. steel pipe is supported on concrete piers built up to carry the pipe across the channel at a height sufficient to provide clearance above possible flood stages. Here rocker arms are pin-connected to ears welded to stiffener rings encircling the pipe. In this case the pipe is stiff enough to be self-supporting between the piers, which are on 41-ft. 8-in. centers (except for shorter spans adjoining expansion joints), and the entire load of the line is transmitted through the rocker arms to bedplates on the piers.

This rocker type of support has been in service since last year, and the suspension type of supports has been in use for over three years. According to W. A. Kunigk, superintendent, water division, Tacoma, Wash., they have fulfilled their function with entire satisfaction.

DETAILS of rocker arm supporting pipe on top of concrete piers. Split H-beam stiffeners give the pipe rigidity over its 40-ft. span.


4"x4" H-beam at all circumferential splices
Elevation at Expansion Joint Span
Intermediate spans 41'-8"
6 x 4½" angle rings, continuously welded on both sides of pipe
Arrangement of Rings and Rockers
Full continuous weld 60° bevel
2½" diam turned pin
4-1½"x14" anchor bolts
4"x4"x13.9 lb. H-beam stiffener
Detail of Joint Stiffener

PIN-CONNECTED SUSPENDER for supporting pipe from under side of steel-truss river crossing.



Unhinging 800-ton Lock Gates for Quoin and Miter Repairs

Methods and equipment employed in repairing worn bearing plates and improving pintle bearings and gate sills of the Panama Canal locks

By Clinton Morse
Junior Engineer, Panama Canal, Balboa Heights, Canal Zone

THE FOURTH STAGE of a program calling for progressive replacement of the worn vertical bearing plates on the 92 gate leaves of the Panama Canal lock system was completed April 1, 1935. The bearing plates on eight leaves at Gatun were replaced during this overhaul, making a total of 30 leaves that have been repaired since 1929.

The replacement program requires a biennial overhaul which alternates between the Atlantic and Pacific locks. There is very little interruption to shipping during the overhaul periods, as the parallel chambers permit one chamber to handle the traffic while the other is unwatered and the leaves repaired.

The general problem

The gates are of the mitering type and pivot on hemispherical nickel-steel pintles 16 in. in diameter (Fig. 1). Each leaf is held at the top by a pin connection to a vanadium-steel yoke, which is in turn keyed to anchorages embedded in the lock walls. A feature of the leaves is the use of removable nickel-steel plates for the vertical bearing surfaces (Fig. 1).

The maximum wear occurs at the bottom of the bearing surfaces and causes the leaves to sag and stand open at the miter bottom when the plates at the miter top are in contact. Pressure behind the leaves forces the miter bottoms downstream until contact is made and results in undesirable distortion of the leaves. The downstream movement of the leaves necessitates excessive trimming of the sills, to maintain the desired clearance and tends further to increase the distortion. Fig. 2 indicates the result of wear on the bearing surfaces.

The quoin bearings (Fig. 2) can be made accessible only by raising the leaf clear of the pintle and then moving it from the wall. The largest leaves are 82 ft. high, 65 ft. wide, and have a gross weight of 790 tons. The design of equipment capable of raising and moving leaves of this size presented an unusual problem. Also because of torrential rains for nine months of the year, it is necessary to make the overhauls during the three months of the dry season, and the limited time for repairs made it imperative to design standardized equipment which would be capable of raising the largest leaves and which would function with maximum efficiency.

Various schemes were studied in an effort to find the most satisfactory

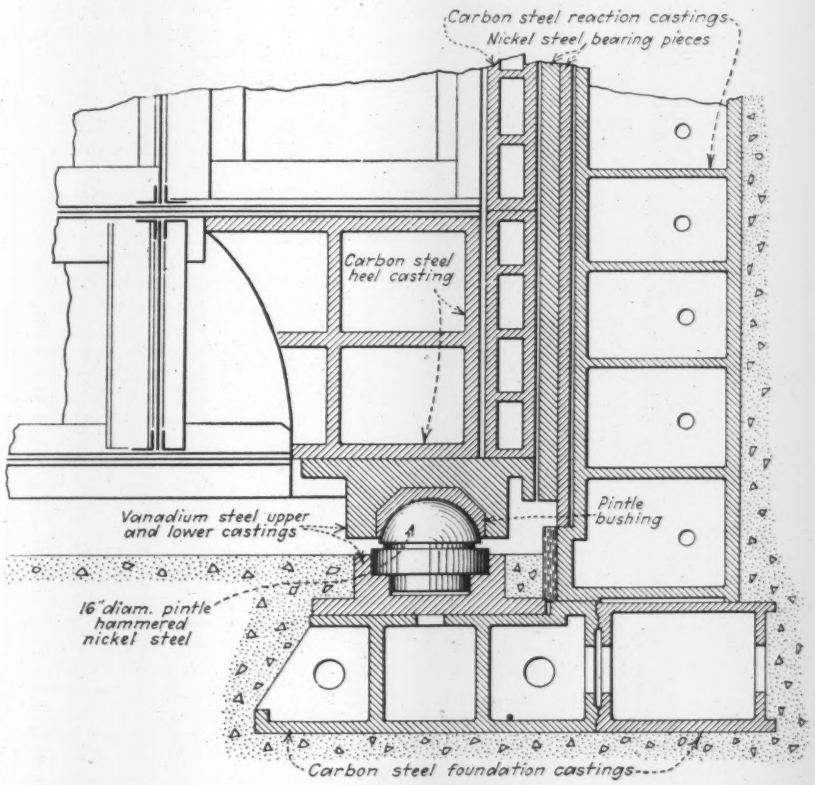
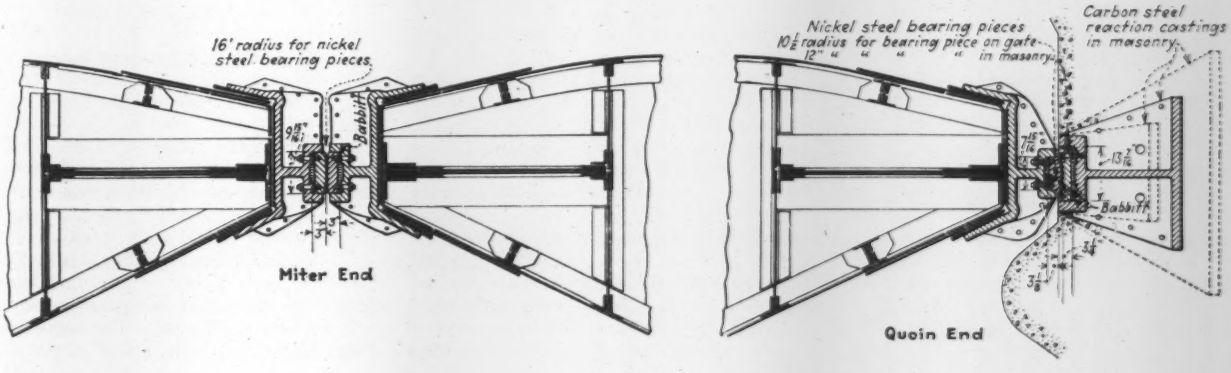

Carbon steel reaction castings
Nickel steel bearing pieces
Carbon steel heel casting
Pintle bushing
Vanadium steel upper and lower castings
16" diam. pintle hammered nickel steel
Carbon steel foundation castings

FIG. 1—VERTICAL SECTION of lock-gate construction at pintle, from which gate had to be lifted clear and moved away for repairs to quoin bearing pieces.

FIG. 2—HORIZONTAL SECTIONS of lock gates at quoins and miters, showing detail of removable bearing pieces that had worn.



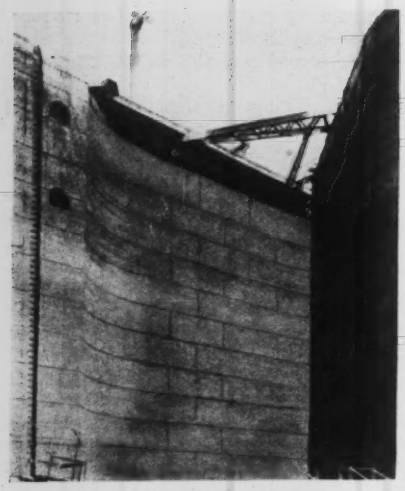


FIG. 3—BRACES from lock wall hold and guide gate leaf as it is rolled out to clear the quoin.

method to be used in an experimental raising of two leaves at Pedro Miguel in 1929. The equipment which was then designed proved so satisfactory that it has been used, with only minor changes, on all subsequent overhauls. Briefly, the adopted raising system makes use of twelve hydraulic jacks, connected to needle-beams under the leaf, which raise the leaf sufficiently to clear the pintle and to allow roller tracks and trains to be placed under the leaf. For simplicity the following description of the equipment, method of raising and moving the leaves and the renewal of the bearings refers to one leaf only. However, four complete sets of equipment are provided, and work is in progress on four leaves at the same time.

Lifting equipment

The small clearance (8¾ in.) under the leaf makes it necessary to place the jacks against the sides of the leaf. The jacks are symmetrically grouped in four sets of three each (Fig. 5) and are placed with the rams down. Each jack is connected to a pair of needle-beams by a yoke over the top (closed end) of the cylinder. The jack cylinders are medium-grade steel castings (federal specifications No. 170) with a finished bore of 5½ in.; they are fitted with rams made from rolled carbon-steel bar stock. The rams are ground to a diameter 0.008 in. less than the bore and are case-hardened. The nose of each ram is ground concave on a 7-in. spherical radius and is provided with a rocker disk of rolled nickel-steel, to form a segmental bearing and insure an even distribution of the load. Each cylinder is equipped with a bleeder valve and a tobin bronze gag plug that can be tightened against the ram to prevent it from falling out during handling. A felt wiping ring, fastened around the end of the cylinder, has proved very effective in preventing small particles of grit from entering the cylinder. Details of the jacks and their connection to the needle-beams are shown in Fig. 6.

A small portable milling machine is used to mill the bottom edge of the leaf at each needle-beam location, to insure even bearing between the beams and the leaf. As a further precaution against uneven bearing, banca tin shims are used at all points of bearing in the lifting system, to relieve, by crushing, any uneven bearing that may exist. Because of high unit stresses and lack of clearance for enlarging the sections, the yokes, links, link pins and needle-beams are made of forged nickel-manganese steel.

Oil pressure is supplied to the jacks by an electrically driven vertical triplex pump having a ½-in. bore and a 4-in. stroke. The pumping unit is compactly mounted on a roofed platform hooked to the downstream side of the leaf (Fig. 4). The twelve jacks are interconnected by flexible couplings to a high-pressure line fastened to the leaf. Connection between the pump platform and the fixed piping is also made by flexible couplings. The high-pressure line consists of ½-in. double extra-heavy steel pipe with forged fittings and specially built valves; 3-ft. lengths of annealed copper tubing fitted with brass nipples are used for the flexible couplings.

The control valves on the pump platform are arranged so that they are all within the reach of one man. A spirit level fastened to the leaf enables the operator to control the leaf (the lighter miter end tends to raise faster), so that both ends are raised at a uniform rate of about 0.3 in. per minute.

One set of twelve jacks and one pumping unit serve two leaves. As soon as one leaf has been raised, the jacks are uncoupled and placed on the other leaf of the pair, but the pump platform is left in place until the leaf has been moved from the wall.

Rolling equipment

The leaves are raised a total of 14 in., to permit the installation of a set of upper and lower roller tracks and a train of rollers at each group of jacks. Each track consists of four 6-in., 27-lb. H-beams bolted together. As shown in Fig. 7, the tracks are centered under the edge of the leaf and assembled around the extended jack rams. To permit this assembly, the flanges of the two outer beams are cut back to the webs in three places. The upper and lower tracks are alike except for the location of these holes, which are placed to allow 4 ft. of travel of the upper track. The three inner beams of each track are bolted together in a unit that allows the outer beam to be slipped into place quickly. The four upper tracks are then tied together by H-beams, to insure their moving as a unit. Each of the four roller trains consists of 22 nickel-steel rollers

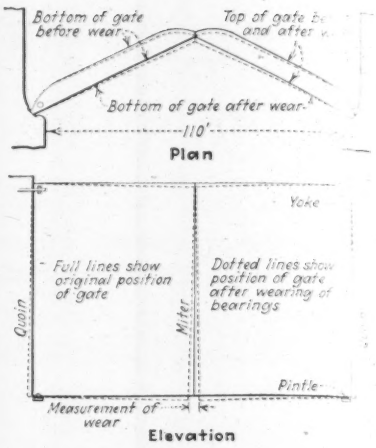


FIG. 4—TENDENCY of bearing-plate wear to distort lock-gate leaves is indicated schematically.

2½ in. in diameter and 32 in. long. The spacing is maintained by long spacer bars placed over the ends of the rollers and normal to their axes.

For rolling the leaf, two hydraulic pusher jacks having a 2½-in. bore and a 4-ft. stroke are suspended from the members that tie the upper tracks together. The jacks are inter-connected, and pressure is supplied by the same pumping unit used to raise the leaf. A small hole drilled through the cylinder wall releases the pressure, thus preventing over-travel, when the leaf has moved the desired 4 ft.

Overturning of the leaf is prevented by a V-shaped structural-steel guide frame (Fig. 3) and four 1½-in. plow-steel cables. Two legs of the guide frame are anchored to the lock wall. The other end, having a 4-ft. slot, rests on the leaf. A casting, which holds a spherical headed pin with a square nut, is bolted to the top center of the leaf. The nut is made in halves bolted together around the spherical head. It travels in the guide-frame slot as the leaf moves from the wall. The cables are used to correct slight lateral deflections during raising, rolling and lowering. Lateral movement of the leaf at the bottom, due to wind load and unbalanced conditions, is prevented by timber shoring at the ends of the leaf.

Preliminary preparations

The locations for the cable and guide-frame anchors are made in the wet season, to permit these anchors to be completely set and grouted in place so that no valuable time is lost at the beginning of the actual overhaul. As soon as the chamber is unwatered and the bottom of the leaf cleaned and scraped, the leaf is placed in the partly open position used in the raising and rolling operations. In this position, the miter end overhangs the sump and necessitates the use of two bearing blocks. The blocks are 3 ft. high, are made up of plates and

angles, and weigh 27,600 lb. per pair. A built-in leveling screw at each corner makes it an easy matter to bring them to grade before grouting in place.

A rolled-steel bearing slab is used at each group of jacks and is provided with slight counterbores to receive the rocker disks under the jack rams. The two slabs at the quoin end rest directly on the concrete sill, while those at the miter end are supported by the bearing blocks. Eight leveling screws are provided to hold the slab while it is being grouted.

The positioning of the leaf must be carefully done, so that the guide frame will fit correctly. This in turn fixes the position of the bearing blocks and slabs. The downstream face of the leaf is used to establish a base line on the chamber floor from which all measurements are made. The location of the base line is held by brass-plug reference points.

While the milling is being done the bearing blocks and slabs are grouted in position, and the fixed piping is fastened to the leaf. Previous to the Gatun overhaul, it was the practice to stretch steel wires between the brass plugs and then bring the punch marks on the blocks and slabs to these wires. Considerable time was saved by having an engineer use two transits and a level to direct the positioning. The tops of the bearing slabs are set as nearly level as is consistently possible, $\frac{1}{64}$ in. being the usual variation allowed, and are checked after the grout is poured. Calcium chloride is used in the cement, to obtain full strength of the grout in 24 hours. After the grout has set, the leaf is again positioned and the distance between the slabs and the milled surfaces on the leaf is carefully checked. Small differences are equalized by spot-welding thin shims in place. A difference of $\frac{1}{16}$ in. in level would put undue stress in the equipment with a possibility of failure due to crushing the edge of the leaf, bending a needle-beam, or crushing the webs of the roller track beams.

The assembly of the jacks and needle-beams, the hanging of the pump platform and connecting to the piping system followed. When the guide frame had been placed, the cables attached and the leaf operating strut removed, the jacking equipment was ready for test.

Each pair of jacks is tested by gradually building up the pressure to 8,800 lb. per sq.in., or 105 tons per jack. The three jacks in each group are then tested at the same pressure. Experience has shown that with properly packed valves and well-tightened connections, very few leaks will develop in the high-pressure lines. During the test of the three jack units, levels are taken on the bearing slabs. In no case has a deflection of more than $\frac{1}{32}$ in. been observed. The pin, yoke and yoke wedges, which hold the leaf at the top and form the connection to the anchorages, must next be removed before the leaf can be raised. The weight of the leaf is carried partly by the jacks and partly by blocking under the ends of the needle-beams during the removal of the top connection. The removal of some of the yoke wedges is rather difficult and calls for considerable sledge-hammer work. A miniature piledriving rig, the hammer of which is used to strike a heavy driving wedge, is very effective in starting the yoke wedges.

Raising and rolling the leaf

The trained personnel and the experience gained on previous overhauls have made raising the leaves largely a routine matter, but the job requires careful supervision, nevertheless. As a safety measure against dropping the leaf due to failure of the oil pressure, follow-up blocking is used under the ends of the needle-beams. The blocks are of steel 6x8 in. in section and are made in thicknesses of $\frac{1}{4}$, $\frac{1}{2}$ and 5 in.

One machinist and two helpers are stationed at each group of jacks while the supervisor assumes a position directly under the leaf so that each group is easily visible. The lifting is started with $\frac{1}{4}$-in. blocking under the beams, and as the leaf raises, the blocking is changed at a whistle signal from the supervisor. When each machinist has signaled a clearance of slightly over $\frac{1}{4}$ in., the whistle is blown and the four groups change blocks together, the $\frac{1}{4}$-in. blocks being removed and a $\frac{1}{2}$-in. block put in place, making a total of 1 in. At the next whistle the $\frac{1}{4}$-in. block is replaced until another $\frac{1}{2}$-in. block can be added. This procedure is continued until ten $\frac{1}{2}$-in. blocks (5 in.) are in place. A solid 5-in. block is then substituted, one block at a time, for the sets of $\frac{1}{2}$-in. blocks. The raising is continued as before until a total of 15 in. of blocking is in place, making a net lift of $14\frac{1}{4}$ in.

The average pressure required to raise the leaves at Gatun was 65 tons per jack, or 5,500 lb. per sq.in. The alignment of the jacks is carefully watched during the raising and lowering operations, as severe lateral thrusts are placed on them if their axes of travel are not parallel. If re-alignment of the jacks becomes necessary, the leaf is landed on the follow-up blocking, the oil pressure released, and the jacks are pushed back into position.

During raising, rolling and lowering operations, the lateral movement of the leaf at the top is checked by observing the clearance between the cross-head on the leaf and the guide-frame slot. Balance is maintained by proper tension in the cables, thus leaving the guide frame free in case of emergency. Lateral movement at the bottom is prevented by keeping the timber shoring firmly braced against the leaf.

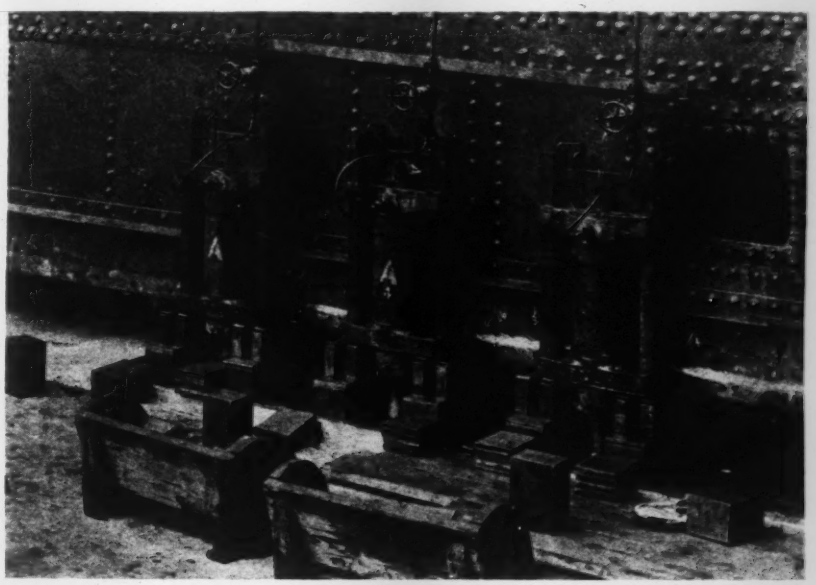


FIG. 5—JACK ARRANGEMENT for lifting gate leaf clear of pintle; four sets of three jacks, six on each side of the gate, were used.

When the leaf has been raised to the required height, the roller tracks and trains are installed. Careful alignment of the rollers is necessary, to insure rolling the leaf away from the wall on the predetermined line. The leaf is then landed on the roller assembly, the lifting jacks are removed, and the pusher jacks installed. The rams of the pusher jacks bear against the lower quoin end tracks. As pressure is applied, the leaf moves from the wall. When the leaf has rolled the required 4 ft., it is securely blocked to prevent it from running away in case of accident. The rolling back and lowering is done similarly but in reverse order.

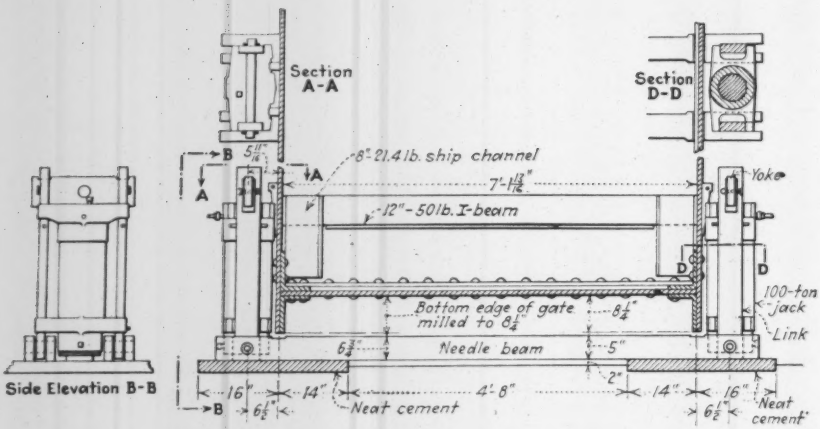


FIG. 6—JACK AND NEEDLE-BEAM ARRANGEMENT when starting to lift gate clear of pintle.

The old bearing plates are removed with a 13-ft. vanadium-steel wedge driven by an air hammer equipped with a special driving head. In order to start the wedge behind the plates, it is necessary to force the top of the plates slightly out of the reaction castings (Fig. 2). This is done by a detonating device screwed into a hole near the top of each plate. This device is made to hold an ordinary shotgun shell and is fitted with a firing pin that can be pulled back against a heavy coiled spring and held in the cocked position by a cotter pin. The wadding and pellets are removed from the shell, which is then filled with nitro-cellulose and black powder. The firing pin is released by pulling a cord attached to the cotter pin; the resulting explosion is sufficient to blow the plate about $\frac{3}{4}$ in. away from the babbitt backing. The use of the long wedge and the detonating device is by far the most satisfactory method yet found for removing the old plates.

The new bearing plates, actually old plates salvaged from previous overhauls and remachined, are set in essentially the same manner as was used on the original construction. The hollow quoins (the concave bearing plates in the lock wall) are set and babbitted first. The leaf is then rolled back, lowered and rehung. The quoin plates (of the leaf) are then set and babbitted. The miter plates are adjusted last.

The removal and resetting of the plates and the pouring of the babbitt are done from double-decked scaffolds that are raised and lowered by jib cranes on the ends of each leaf. These jib cranes have been built of parts salvaged from obsolete equipment. They can be swung in a complete circle, are equipped with a single-drum air-hoist, and have a capacity of 3,000 lb. at a radius of 13 ft.

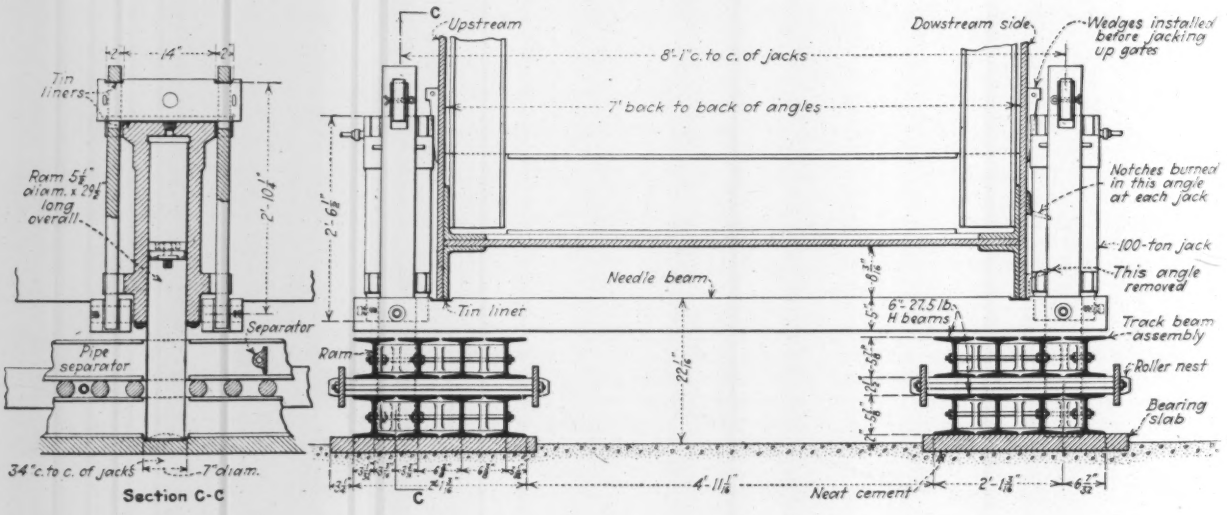
The establishment of a vertical reference wire for setting the hollow quoins is simplified by a device designed by engineers on the Panama Canal. This device consists of two parts: a cross-bar spider fastened in the pintle socket, and an adjustable slide supported on a bent channel fastened in the yoke casting. A transit is used to bring the adjustable slide to its correct position and requires very careful work. With the slide correctly adjusted and clamped in position, a No. 13 piano wire is passed downward through a hole in the slide and fastened to the spider. The plates are then set with a gage from this reference wire. The gage is held horizontally between the wire and the plate, and the plate is then twisted in the casting until a scratch mark on the gage coincides with the reference wire. When the plates have been correctly adjusted, the babbitt backing is poured.

The quoin plates are set by jacking them tightly against the hollow quoins and at the same time twisting them until the line of contact is centered on the plates. The plates are required to be set so that it is impossible to push a 0.005-in. feeler between the contact faces.

The miter plates are set early in the morning by bringing both leaves to the miter position. The bottoms of the bottom plates are placed in contact, but the tops of the top plates are separated by a $\frac{1}{2}$-in. filler. These plates are then tightly bolted in place, and a reference wire is stretched from top to bottom. The remainder of the plates on the leaf are set by gages from this wire.

The space back of the plates is filled by pouring babbitt into sheet-iron funnels screwed into tapped holes in the face of each plate. The babbitt is melted in pots placed on a double-ended oil-burning furnace located on the chamber floor. When the molten babbitt has reached the proper temperature, the pot is lifted into position by a steam crane on the lock wall. Four men are required on the scaffold during the pour: two men to tip and steady the pot, a helper and a signal man. The lower 25 ft. of the plates is heated with hot air for two hours before starting a pour, to dry out any moisture and to

FIG. 7—JACKS EXTENDED to lift gate and rollers, and tracks installed ready to roll gate away from quoin.



prevent too rapid cooling of the babbitt. The upper plates are heated sufficiently, by conduction as the pour progresses, to make preheating unnecessary. The pouring of the molten babbitt from the small and swinging scaffolds was undoubtedly the most hazardous work of the entire overhaul.

As each leaf is overhauled, minor changes are made in certain details of the original design.

1. An automatic pintle-oiling device is installed, whereby a small quantity of grease is forced into grooves in the new pintle bushing each time the leaf approaches the miter point.

2. Concrete sills are used to replace the original wooden sills, which are subject to attack by the teredo. The capping sills on the leaf are increased in thickness, to allow for additional trimming.

3. Slightly projecting beads of babbitt are poured into dovetailed grooves in the faces of the miter and quoin plates. Their purpose is to secure a watertight bearing by crushing and filling in the small depressions due to slight inaccuracies in setting the bearing plates.

The writer wishes to express his appreciation to the American Society of Civil Engineers for permission to reproduce certain photographs and drawings that were used to illustrate a previous article (*Proceedings*, Am. Soc.C.E., January, 1934, pp. 37-61).

The gate repairs at Gatun were made by the forces of the Panama Canal. L. W. Lewis, office engineer, and E. D. Stillwell, superintendent, locks division, were the officials directly responsible for the satisfactory completion of the work. H. M. Thomas, assistant superintendent, was in direct charge of the mechanical forces, and the writer was in field charge of engineering and inspection.

Heavy-Service Grizzly Bar Developed at Grand Coulee

MOST of the millions of yards of material excavated from the site of the Grand Coulee Dam are handled by conveyor belts (*ENR*, Aug. 1, 1935). To protect the belts from the damage and excessive wear of handling boulders and rock fragments, these are screened out by grizzlies over the belt feeder units, which are 40-ft. flights of steel-plate conveyors in pits about 41 ft. long and 8 ft. wide. As the work has progressed the grizzlies have been redesigned several times, to improve and strengthen them. The accompanying drawing shows the latest development of an improved design.

The first grizzlies used were of the relatively light construction commonly employed; these were wholly inadequate and were soon twisted and bent. When it is remembered that boulders as large as will go through a 5-cu.yd. dipper on a power shovel are dumped on these grizzlies and that the material which does not promptly fall through the open spaces is shoved off by a bulldozer, it becomes apparent that very heavy construction is necessary.

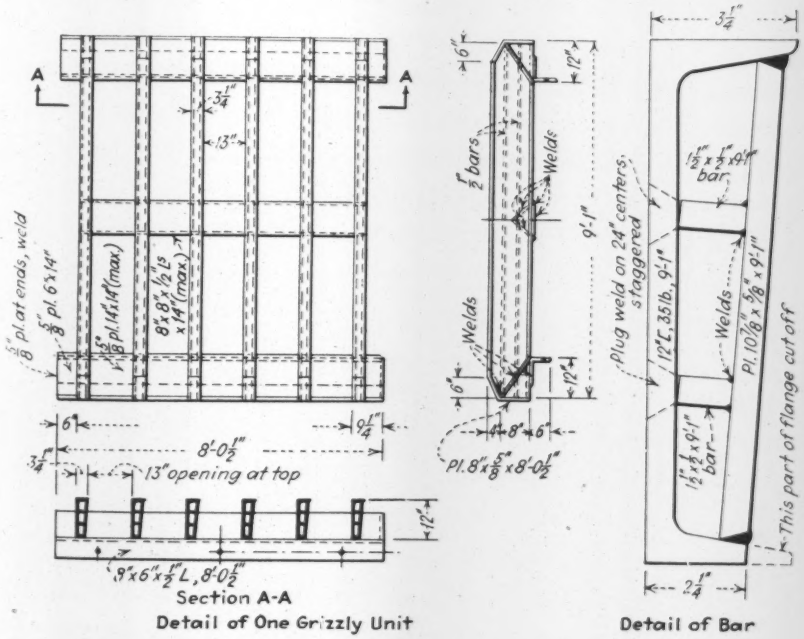
After a process of evolution a grizzly was developed consisting of several independent sections, any one of which could be quickly removed and replaced. The novel feature of these units is the box beam built up by welding additional material into a 12-in. 35-lb. steel channel. In addition to having great strength, these box beams have a tapering section, thus giving the spaces or openings between bars a minimum width at the top; anything that can get into the space between the bars on the upper surface has ample clearance below that point.

The channel iron is first cut with a torch to give it a width 1 in. less on the bottom than on top, and then the $\frac{5}{8}$-in. plate, to which the two $\frac{1}{2}$-in. bars have been welded previously, is placed against the channel and welded along both edges. The final operation to complete the assembly is to make plug welds in tapered holes along the line of each of the $\frac{1}{2}$-in. bars. These holes are on 2-ft. centers and are staggered for maximum rigidity. The welds are built up only to a depth flush with the face of the channel iron, leaving the surface free from resistance to passing material.

Grizzlies so made have been found sufficient for handling the Grand Coulee spoil. Sometimes the formation excavated is such that very large clods arrive at the grizzly composed of material that would readily go through if the clod formation could be broken up. To meet this condition, tractors are made to climb up on such clods as they stand on the grizzly. In some cases, in order to break down the clod formation, it is necessary to move the tractor back and forth on the clod, operating the treads in opposite directions. A sudden yielding of the clod, bringing the tractor treads against the grizzly bars, was found to cause damage because tractor cleats would catch in the grizzly bars.

Wherever the clod formations are bad, therefore, a tractor is equipped with treads specially prepared in which the plates are perfectly smooth and are set close together. While such a tread would not have the traction necessary for the usual tractor service, it is well suited to crushing clods and does not damage the grizzly bars.

Work on the Grand Coulee project is under general contract to the M.W.A.K. Co.; H. L. Myer is general manager. A full description of the construction plant and methods was published in *Engineering News-Record*, Aug. 1, 1935.



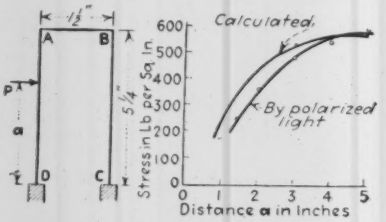
DETAILS OF FEEDER GRIZZLY, showing unit construction and rugged design of bars with a tapered section.

From Job and Office

Influence Lines Determined by Polarized Light

By Samuel Lerner
Assistant in Structures, Brown University, Providence, R. I.

POLARIZED LIGHT may be used conveniently in the following way to determine influence lines of indeterminate structures. First, place the bent under circularly polarized light and apply a load P until a first-order green appears at D. If the stress which the first-order green represents is S, then S/P is the stress at D due to a unit load.



BENT AND STRESS influence line determined with photo-elastic apparatus. The calculated influence line is also given, for comparison

By applying horizontal loads at various points along the leg DA of the bent until the first-order green appears at D and then dividing S by the value of the corresponding load the influence line is ready for plotting.

The stress-influence line at D was computed by the slope-deflection method and compared to the one found by polarized light, as shown in the accompanying chart.

Pipe Discharge Computed By One Slide-Rule Setting

By Benjamin C. Seal
U. S. Engineer Office, Canton, Mo.

A COMMON PROBLEM in seepage or pump-discharge studies is to compute the amount of water flowing from a pipe by using coordinates of the stream trajectory. By following the method outlined below, the discharge from a circular pipe flowing full can be quickly computed with an accuracy comparable to that with which the measurements can be taken.

Three measurements are made, the diameter of the pipe in inches and h and d in feet, these being the horizontal and vertical coordinates of any convenient point on the trajectory, taking as zero the center of the stream at the pipe outlet. The slide-rule used is the polyphase duplex. Remove the slide, turn it over and replace it.

(1) Place the distance d on the CF scale opposite h on the A scale.

(2) Move the cross-hair to the square of the diameter in inches on the D scale.

(3) Read the discharge in gal. per min. on the CF scale.

The proof is as follows:

$Q = 2.45\,VD^2$, in which Q is in g.p.m., V in ft. per sec., and D is the diameter in inches.

$$V = \frac{4d}{\sqrt{h}}$$

$$Q = 2.45\,D^2 \times \frac{4d}{\sqrt{h}}$$

$$Q = 9.80\,\frac{dD^2}{\sqrt{h}}$$

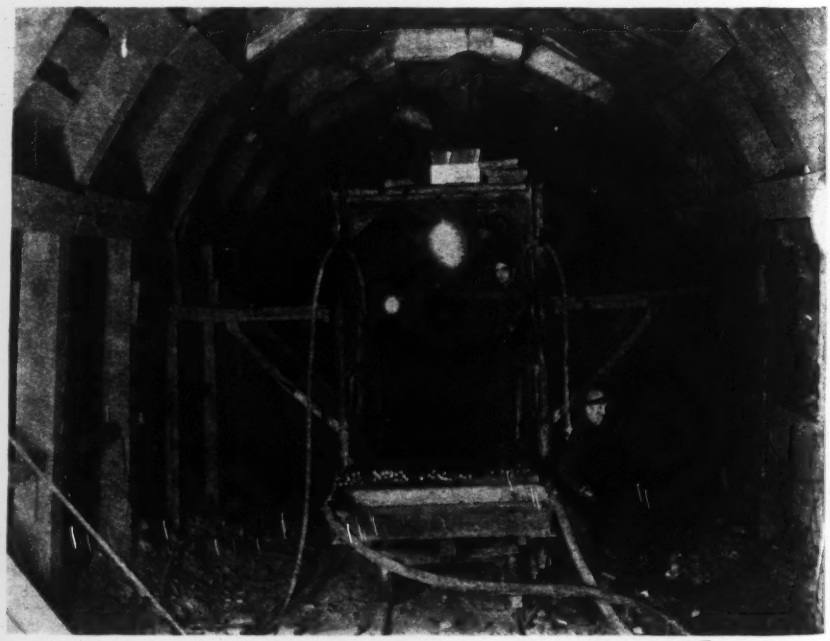
The 9.8 is changed to 10, which not only introduces a correction for air resistance but permits rapid and reasonably accurate results.

Drill-Carriage Wings Held Up by Toggle Braces

DRILL CARRIAGES used in the tunnels of the Metropolitan Water District aqueduct are equipped with working platforms on either side, usually referred to as wings, which fold down against the frame of the carriage itself before the rig is moved. As a means of expediting the setting up and taking down of these wings, a plan recently tried out consists of braces or bracket supports with a central hinged joint that will drop down, under the influence of gravity, slightly below the center line. Thus, to make the toggle brace lock in position, it is only necessary to raise the wings to place; once the hinge is below the center, the brace is held in place by gravity.

When the carriage is to be moved, a workman raises the platform slightly, the toggle braces are pressed lightly on the under side so as to raise them past the center line, and then the wing can be lowered against the carriage side. In operating the braces no bolts have to be loosened or removed, and the device is believed to be safe because the wings cannot fold down accidentally.

TOGGLE-BRACED WINGS in working position on drill carriage at a heading.



Temperature Correction Table for Use With Steel Tapes

SINCE steel measuring tapes expand and contract with changes in temperature, it is necessary to make frequent corrections to avoid large cumulative errors while taking over long distances in extremely hot or cold weather. On the more accurate surveys corrections must be made for slight temperature changes. In order to overcome the necessity of a number of field computations, George C. Love, civil engineer, Durham, N. C., worked out a table of corrections for temperature variations. The table is for use with a 100-ft. steel tape and covers temperature variations up to 60 deg. Since the coefficient of expansion is .0000066666 per degree of temperature change, the 100-ft. tape would expand .0006 ft., and for a varia-

tion of 15 deg. F. the change in length would be .01.

The following table assumes that the tape is standard at 68 deg. F. When the observed temperature is less than 68 deg. F., the correction is to be subtracted from the observed distance; if the temperature is greater, the correction should be added.

Degrees Plus or Minus	Correction Per 100-Ft. Station	Degrees Plus or Minus	Correction Per 100-Ft. Station
0	.0000	31	.0207
1	.0007	32	213
2	13	33	220
3	20	34	227
4	27	35	.0233
5	.0033	36	240
6	40	37	247
7	47	38	253
8	53	39	260
9	60	40	.0267
10	.0067	41	273
11	73	42	280
12	80	43	287
13	87	44	293
14	93	45	.0300
15	.0100	46	.0307
16	.0107	47	313
17	113	48	320
18	120	49	327
19	127	50	.0333
20	.0133	51	340
21	140	52	347
22	147	53	353
23	153	54	360
24	160	55	.0367
25	.0167	56	373
26	173	57	380
27	180	58	387
28	187	59	393
29	193	60	.0400
30	.0200		

Distinguishing Level Rods Eliminate Transpositions

IN AN EFFORT to eliminate transpositions of data in precise leveling, members of the Division of Geodesy, U. S. Coast and Geodetic Survey, have developed what is called the "Red Rod Method," according to a report by W. W. Studdert, printed in the September-October, 1935, issue of the *Geodetic Letter*.

When doing single-line precise leveling two rods are commonly used. On the back of one of the leveling rods a brilliant scarlet stripe, ½ in. in width, is painted the full length of the rod. When an observer reads the rod he calls "Red" and the recorder enters an R just above the ⅓ meter reading in the back-of-rod column. The other, or white, rod is read and entered in the usual manner.

By using this method, when the rodmen drift, as along a railroad line, the R entries from the red rod will all be in one column, indicating that the red rod was either in the rear or in the lead, on that survey. When the rodmen leapfrog, or alternate, along the level line, the R entries in the back-of-rod column will alternate with the regular rod readings. The consistency of the red-rod readings will inform the recorder immediately if a transposition has been made, and the mistake can be corrected before the instrument is moved. If a transposition should get by without being noted in the field, a glance at the notes at the end of the section or in the office will tell just where the transposition occurred. Besides identifying the rod readings this method identifies the points at which each rod was held, and as the rodmen use the same rods every day, it is easy to tell which rodman held each point.

The Geodetic Survey has issued instructions that all leveling parties are to use this method when doing single-line work and are to report on its general effectiveness. Using the red rod on double run lines has been left to the discretion of the chiefs of parties.

Canvas Hoods Over Sand Piles Keep Water Content Uniform

TO PROTECT sand stockpiles from weather, canvas hoods or "skirts" have been employed with success on sand waiting to be used in concrete on the Bonneville project. The use of the covering was suggested to prevent sudden changes in moisture content rather than because of any objection to additional moisture. In other words, the amount of free water in the sand was not an important matter provided the amount remained reasonably uniform. In locations where considerable quantities of rain and snow fall, particularly when a crater has been formed in the stockpile by withdrawal of material from the bottom, the moisture content may fluctuate suddenly and widely, thus making it difficult to adjust the quantity of water added at the mixer to maintain uniformity in the specified water-cement ratio. Without protection it was found impossible to maintain uniform moisture content in the sand stockpiles during the rainy season. No such protection is required on gravel stockpiles. Because of the greater porosity in that material water drains off quickly and does not remain to affect moisture content of the resultant concrete mix as in the case of sand.

Another advantage of the canvas hoods is that they prevent the finer particles from being segregated or blown away entirely as the sand falls from the conveyor belt to the top of the stockpile below. If high winds blew at times when the stockpile was drawn down to minimum height, this risk would be important.

The method of securing the hoods, as shown in the accompanying picture, is to fasten the four corners by rope stays anchored to corner posts. Supplementary anchorages, to tie down the edges of the canvas between the corners, are provided by sandbag weights attached to ropes passing over the canvas and fastened to the corner stays. It is believed that this type of covering costs less than framing of any kind. The results on the Bonneville job have been highly satisfactory.

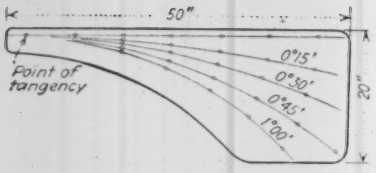
The Bonneville project is being constructed by the Corps of Engineers, U. S. Army. Colonel T. M. Robins is the division engineer, and Major C. F. Williams is the district engineer. I. E. Burks is chief concrete technician.

Templet Made for Protecting Four Low-Degree Curvatures

By A. A. Kirkwood,
Locating Engineer, Oregon State Highway Dept.

ON account of the physical characteristics of the country through which the road must pass and because of a desire to preserve the scenic beauty, the Oregon state highway department found it necessary on the relocation of the Columbia River Highway to project long curves of a very low degree of curvature. It was found that to use individual templets for all of the curves would be inefficient and expensive. To overcome these difficulties, one templet, on which curves of 15, 30 and 45 min. and 1 deg. were inscribed, was made from a 20x50-in. sheet of 30-gage celluloid.

CANVAS HOODS prevent rain, snow and wind from interfering with desired uniformity of water content of sand taken from stockpiles to concrete mixer on the Bonneville project.

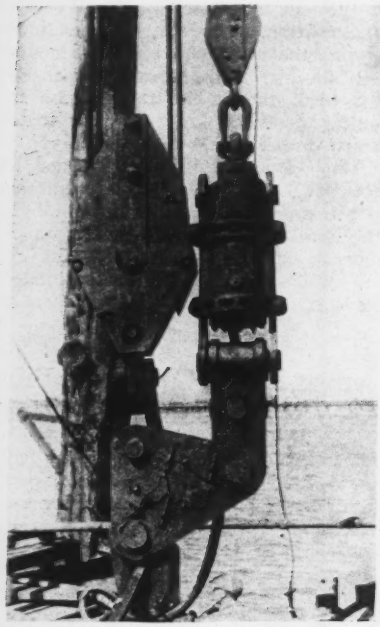


CURVE TEMPLET used for laying out low-degree curvatures on relocation of the Columbia River Highway.

The sheet of celluloid was shaped as shown in the illustration, and the various curves were then inscribed. A tangent was engraved, parallel to and about 1 in. in from the long side of the sheet. The curves were based upon a common point of tangency, near one end of the tangent line, and the circular curves were plotted to the right of this point. The curves were carved in with a knife blade attached to a hinged bar that served as a radius for the various curves. The blade was placed at the desired radius distance from the axis of the movable bar; then the table upon which the celluloid sheet was firmly fastened was placed so that the knife point coincided with the common point and the tangent line on the sheet was exactly at right angles to the radius. The radius was then swung on its axis, engraving the curve on the sheet. The other desired curves were engraved in the same manner after the blade and the table had been shifted to fit the required radius lengths. Figures denoting the degree of curvature of each line were stamped in with steel dyes, and small holes were drilled through the sheet at points 10 in. apart on each curve and on the tangent line so that the curves could be plotted onto a map. After the curvatures were inscribed the lines were filled with aluminum paint so that they would stand out clearly when the templet was placed on a map showing contours, streams and structures.

Pile Extractor Aids on 125-Ton Pull

IN REMOVING sheetpiling used for cofferdams on the East Bay crossing of the San Francisco-Oakland Bridge, special equipment was used to provide the very heavy pull required. When ready for removal, the piles first were driven slightly to loosen them from the concrete seal inside the cofferdam, and then an upward pull was applied by means of a floating A-frame derrick equipped with a 16-part tackle of 1-in. cable. The 125-ton pull exerted by this equipment required some additional aid, and a steam pile extractor was adapted, by manufacture of a special coupling, for use in conjunction with the lifting tackle. No extractor heavy enough to take the direct pull could be found, so a stock model, designed for a maximum pull of about 25 tons, was used and was coupled to the lower block of the lifting



THE EXTRACTOR is operated by steam and is handled by a 5-part line independently of the 16-part main lifting tackle.

tackle by an offset plate, as shown in the accompanying picture.

With this device the work of pile removal was expedited, and it was used on most of the seventeen pile piers on this contract. The usual practice was to connect the tackle to the sheetpiling and put on the full lifting strain that the derrick could exert and then to "jar" the pulling tackle by setting the extractor in operation. If the pile did not start to come up immediately, the extractor was used intermittently until it did, steady pull being maintained meantime by the lifting tackle.

The device was developed by the engineering staff of the contractor on this part of the work, Bridge Builders, Inc.

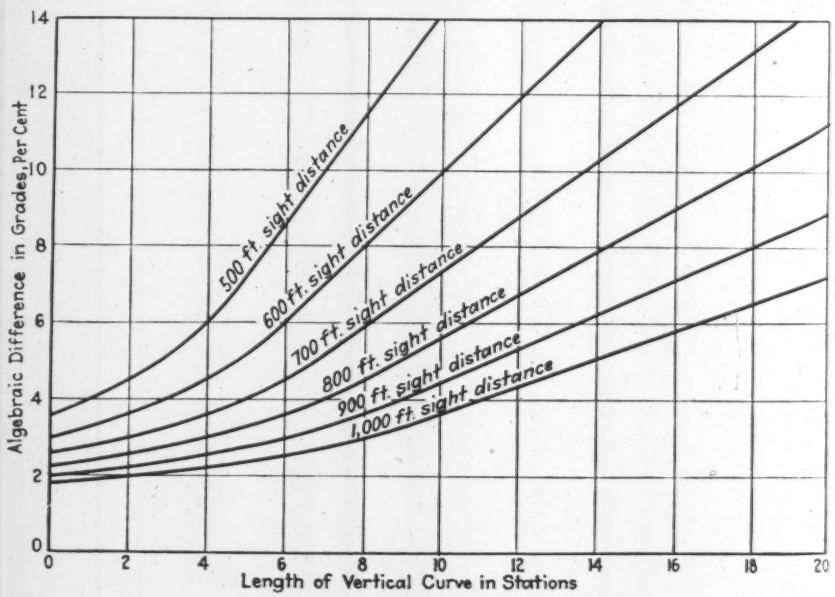
Pile-Treating Specifications for Using Metallic Salts

METALLIC SALTS have been used to a limited extent in treating piles for highway bridges built by the Oregon State Highway Commission. After some experience standard specifications were adopted as a guide for future contracts of a similar sort. These specifications contain the following provisions:

"All sticks to be treated shall be of live green timber having a sapwood ring not less than 1 in. in average thickness. The timber shall be free from defects or blemishes which would prohibit a full circumference of treated wood.

"All limbs shall be cut approximately flush with the body of the pile, but the outside fibers of the pile shall not be cut or abraded in such manner as to cause leakage of chemicals during treatment. Piling shall be delivered at the treating plant unpeeled and shall not be peeled until after treatment.

"The treatment shall be accomplished



CHARTING LENGTHS OF VERTICAL CURVES

Sight distance chart showing length of vertical curve for various sight distances based on line of sight 4½ ft. above ground. The curves are based on the formulas: $L = 2D\frac{8H}{G}$, valid only where L is less than D; and $L = \frac{GD^2}{8H}$, valid only where L is greater than D. In these formulas, L = length of vertical curve in stations, G = algebraic difference in grades, H = distance of line of sight above ground, and D = sight distance. This chart has been used often by engineers of the Texas state highway department in preparing plans. The formulas were derived and the chart was worked out by P. B. Edmondson, Childress, Tex., of the engineering staff of the department

by applying to the end of the stick a solution of toxic chemicals in combination with suitable fluxing and fixitive re-agents. The application of chemicals shall be made under pressure in such manner as to force the chemical constituents into the sapwood and shall continue until the minimum toxic chemical content of the wood in any portion of the circumference of the treated ring and at any point in the length of the pile specified to be treated shall be as follows:

	Oz. Per Cu.Ft.
Arsenous oxide (As_2O_3)	4
Hydrous copper sulphate ($CuSo_4 + 5H_2O$)	6
Hydrous zinc sulphate ($ZnSo_4 + 7H_2O$)	6

"The chemical content of the sapwood shall be determined by an analysis of the shavings from borings made at the end of the length specified for treatment which is farthest from the point of application of the solution."

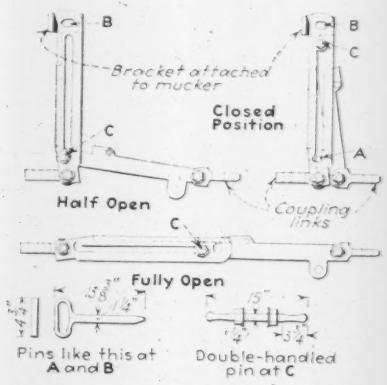
Special Muck-Car Coupling Permits Large Uniform Loads

A DOUBLE-HINGED coupling for connecting a Conway mucking machine to the side-dump car into which the muck is discharged has been designed for use on the Mono Craters tunnel now being constructed by the city of Los Angeles. With this adjustable coupling it has been possible to add about 13 cu.ft. to the average load of muck carried by the 70-cu.ft. (water level) dump cars, thus materially improving efficiency in mucking operations.

Special requirements arose from the fact that the narrow tunnel width (9 ft. 8 in. between plumb posts of the temporary timbering) made it necessary to use narrow cars in order to afford room for passing on the double tracks at California type jump switches. The narrow cars were made rather long (110½ in.) in order to get capacity. The horizontal jack-knife coupling furnished by the mucker manufacturer had only one extension. In the closed position this coupling did not bring the long cars close enough to the mucker to fill the far end, and in the open position it was not possible to fill the near end. For this reason it was decided to try whether a special coupling would make full loading possible. The problem was assigned to E. V. Hendrix, general foreman on the Mono Basin project, who devised a coupling that met all requirements.

The coupling link has two hinges with adjustable members moving in a vertical plane (see the accompanying drawing). With the coupling in its first or closed position the car is held close to the mucker and the far end of the car is loaded to capacity. Then, without interrupting the mucker operation, the pin at *A* in the sketch of the closed position is pulled and the link immediately drops into half-open position, in which the discharge end of the belt conveyor from the mucker is over the center of the car. After the right amount of muck is loaded in this second position the *B* pin is pulled and the coupling takes the fully open position, in which the near end of the muck car is loaded.

In fully open position the two links of the coupling are held rigid so that they transmit the thrust when the mucker



DETAILS of the double-hinged muck-car coupling.

backs up, by reason of the toggle action at the central joint of the coupling. That is, the pull of gravity holds the two links in a wedged relationship so that there is no danger of thrust in the coupling causing it to buckle up into the half open position.

After the car has been fully loaded and uncoupled from the link two men take hold of the handle marked *C* in the sketch and raise the inner ends of the two links so that the hand pins can be reinserted at *A* and *B*, thus fastening the coupling in position to be attached to an empty muck car.

The project is under the general direction of H. A. VanNorman, chief engineer and general manager, Bureau of Waterworks & Supply, city of Los Angeles. H. L. Jacques is construction engineer.

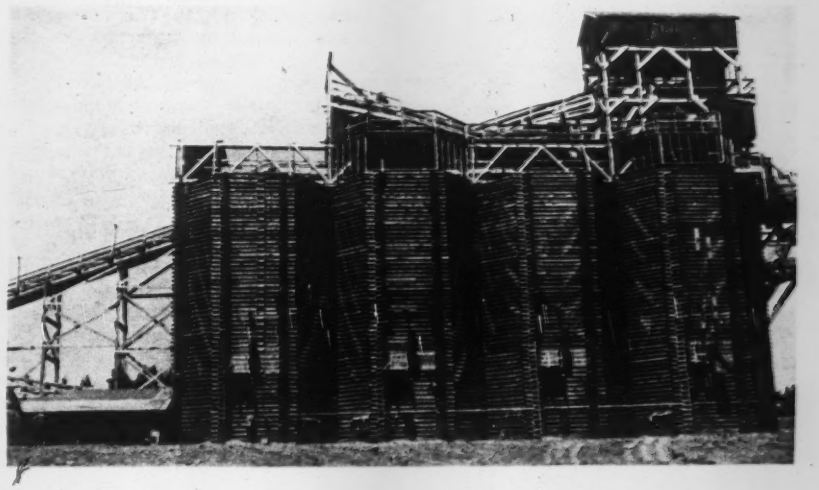
Aggregate Silos at Bonneville Use Open-Crib Construction

AGGREGATE in four sizes for concrete that will go into the spillway dam on the Bonneville project is delivered in standard-gage, bottom-dump cars to the north side of the river opposite the dam. The materials are dumped from the cars into bins beneath the track, and a belt conveyor raises them to silos nearby built of timber. The silos, in turn, deliver to a belt passing beneath them and running thence to the concrete mixing plant. In building the silos, it was found possible by a special construction to save 40 per cent of the timber that would ordinarily be used.

The silos are octagonal in plan, and one of the eight sides of each cell is common to two cells. The inside width is 30 ft. in the clear, and the height is 57 ft., giving a capacity of about 1,600 cu.yd. each. The plan of construction was to use timbers 6 in. thick and ranging from 16 in. wide at the base of the silo to 10 in. wide at the top, those of one side being interleaved with those of the adjoining sides. The timbers, dressed on both sides to secure uniformity of thickness throughout, were set with outer faces flush and were drift-bolted together at the intersections. Timbers were ordered "in 16-ft. lengths" and were put into the silos just as they came from the mill: that is, an average of 6 to 8 in. in the lengths was of no consequence, and it was not necessary to fit the ends—excess length was simply allowed to project beyond the intersection. This plan of construction not only saved about 40 per cent of the timber that would have been required for a solid wall but decreased the labor cost by eliminating the necessity of trimming ends or making bevel cuts to fit.

Even with aggregate sizes most inclined to take a flat angle of repose, the amount of spillage through the walls

TIMBER SILOS, octagonal in plan, for storing concrete aggregate at Bonneville.

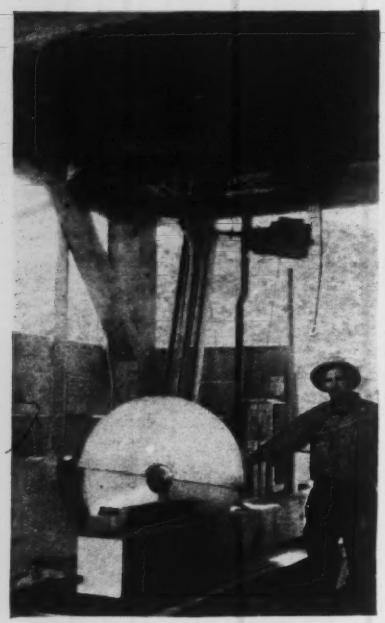


proved to be negligible, and use of these structures confirmed the original opinion that lining was unnecessary.

The timber silos were designed and built by the Columbia Construction Co., contractor for the Bonneville Dam spillway.

Turntable Swing Saws Speed Work on Tunnel Timbers

TIMBERS for tunnels of the Metropolitan Water District of Southern California are cut to the proper length and bevel by a 30-in. circular saw mounted, with its driving motor, on an overhead turntable so it can be swung



TURNTABLE SWING SAW can be set quickly to cut timbers at any angle desired.

to cut at any desired angle. There are eight of these saws at as many strategic points along the aqueduct. One carpenter and a helper at each saw can cut in one shift more timber than can be used in three shifts in a fully timbered portion of the tunnel.

Three-Way Tunnel Track Siding Speeds Operations at Face

A PORTABLE tunnel track siding, which facilitates movement of equipment near the heading face and which has speeded up tunnel operations materially, is in use in both portal headings of the Mono Craters tunnel, now being driven by the city of Los Angeles as an extension to the Owens Valley Aqueduct. The siding provides three tracks with the use of four rails and permits the locomotives and dump cars to pass each other near the face by using the outside tracks. The center track is used by the mucking machine.

With a total clearance of only 9 ft. 8 in. inside the temporary tunnel support, the ordinary type of double-track siding, even with long switch points, did not afford sufficient clearance for the mucking machine. Therefore, some special provision is required in those sidings on which the drill carriage and mucking machine are to pass. Usually this can be arranged conveniently at some point where the tunnel section is somewhat oversize, but it is not economical to provide these passing points at such frequent intervals as are desirable for speedy switching of muck trains near the face. This led to the design of a type of siding that could be moved forward easily as the work progressed and that would serve the muck-train requirements but would not interfere with moving back the mucking machine.

This special siding is a complete track structure, consisting of four lines of 40-lb. rail, making three 24-in.-gage tracks. The rails are held in position by $\frac{5}{8}$x4-in. steel straps, which serve as ties and which have welded tieplates that engage the rail flanges. Three-way switches at either end shunt main-line traffic to or from any one of the three tracks. The switches are served by a short length of incline or ramp rail with a feathered end of practically zero thickness where the wheels are picked up from railhead on the main line. The thickness (or height) of the feather-end rail increases from nothing at main-line railhead to standard rail height where the switch point is reached. (A feather-end switch laid on top of existing track is commonly known in Western tunneling practice as the "California type.")

With the arrangement described, the entire length of the three tracks is superimposed above the original tunnel track; suitable ballast support is worked up under the outer rails that overhang on either side. When it is desired to move the siding, it is only necessary to jack it up, a portion at a time, and place dollies beneath it supported on the rails of the original tunnel track. Four such dollies are sufficient to move the siding, and the entire moving operation consumes only about 30 min. The length from feather-end through the turn-out curve at each end is 33 ft. The length of the straightaway section of the siding is 170 ft., which easily accommodates a locomotive and a ten-car train of the long side-dump cars that are standard in this tunnel. The over-all length of siding can be varied as required, of course, by lengthening or shortening the straightaway section.

Highway Research Board Discusses Economic and Technical Subjects

THE INTERESTS of research, as indicated by the recent meeting (Dec. 5 and 6) of the Highway Research Board at Washington, have become as much concerned with the use of roads and their operation as with materials and design. At least as many reports and papers discussed traffic control and transportation economics as were concerned with problems of engineering technique; they centered, however, on details rather than on broad planning policies. Specifically the subjects considered can be classified as materials, pavement structure, traffic control, transportation economics and the special technique of concrete vibration and soils stabilization. This range of subjects and the profuse detail in which they were discussed permit only bare summary. The newer developments will be reviewed separately in future issues.

Freezing and thawing

Reporting for the committee which has undertaken a study of the effect of freezing and thawing on concretes containing cements of different composition, H. S. Mattimore, Pennsylvania Department Highways, stated that tests were now in progress in seven laboratories, and while certain trends were indicated the determinations had not reached the point where any direct comparison can be made on the resistance of concrete of different compositions. As the study has proceeded it has clearly appeared that both the speed of freezing and the presence or absence of circulating air have a direct effect on results.

Three papers on vibration of pavement by R. R. Litehiser, Ohio State University; F. V. Reagel, Missouri Highway Department, and R. B. Wills, Kansas Highway Commission, described further progress in the experiments being carried out on test sections. The results showed distinctly increased strength but difficulty in spreading the dry mixes and in preventing honeycombing at the slab edges. M. O. Withey, University of Wisconsin, reported in this connection that a series of tests made on 6x8x52-in. concrete beams internally vibrated from one end of the mold; using no slump and ½-in. slump mixes, there was a marked reduction in time required to compact the beams when the higher frequencies of vibration were used, and this effect was more marked in case of the very dry mixes.

Reporting on cushion materials for brick pavements, J. S. Crandell, University of Illinois, called attention to two recent examples of the use of powdered asphalt and sand. H. F. Kriege, France

Stone Company, presented an extended analysis of sodium sulphate tests of aggregates, arriving at the conclusion that without substantial modifications its results might be uncertain indicators of soundness.

Design and structure were the subjects of papers by H. J. Gilkey, Iowa State College, on high elastic steel for reinforcement; by M. G. Spangler, Iowa State College, on concrete slab stresses; and by J. W. Kushing and W. O. Fremont, Michigan Highway Department, on pavement joints. Developing a theory of local transmission based on tests, Mr. Kushing and Mr. Fremont arrived at the conclusions that the intensity of load transfer over the joint will not exceed 2 per cent of the concentrated load per linear-inch of joint, and that about 90 per cent of the load transferred is effected over 3 ft. of the joint in the immediate vicinity of the load. The series of tests of small beams described by Professor Gilkey, and those on stresses in concrete pavement slabs were reported as awaiting completion and analysis. Other papers relating to design were on longitudinal cracking in concrete pavements by H. F. Janda, University of Wisconsin, and brick road experiments by R. R. Litehiser.

Traffic control

Traffic control and safety were the subjects of papers on safety zones by H. S. Simpson, American Transit Association; on motor-vehicle inspection, by W. S. Canning; and time for passing vehicles, by B. D. Greenshield. Traffic counts were reported by Mark Morris, Iowa Highway Commission, and N. W. Dougherty, University of Tennessee.

Soil stabilization was considered in papers by C. A. Hogentogler, Bureau of Public Roads; Hans Winterkorn, University of Missouri; J. W. Kushing, F. E. Kelley and G. E. Ladd, Bureau of Public Roads. Roadside development was discussed by L. M. Keith and Franz Aust. Papers by Anson Marston, R. Winfrey, A. J. Bone, W. E. Lay and L. E. Conrad developed various subjects of transportation economics.

Letters to the Editor

Terminology in Soil Mechanics

Sir—In a letter published in your issue of Nov. 7, 1935, p. 648, Professor Morrison of the University of Alberta has raised a question of terminology in soil mechanics which deserves more attention than may be given to it by casual readers. In a comparatively new field going through a process of rapid development, investigators are constantly searching for new and distinctive terms which are self-defining and are not easily confused with other terms with different meanings. With a number of investigators working more or less independently, confusion is liable to result, and in some cases long-standing differences of opinion may arise from nothing more than matters of definition.

In using the term "plastic limit" the writer was following a terminology with which he was familiar and which may be found somewhat infrequently in current literature. The term "plastic limit" for plastic solids is analogous to elastic limit for elastic solids. It represents a limiting value of stress which serves as a line of demarcation between two stages of radically different behavior.

The writer has upon several occasions voiced an objection to the use of "plastic limit" in connection with the Atterberg test under the impression that the various limits used in connection with mechanics of materials refer only to limiting values of stress. The plastic limit as used in connection with the Atterberg tests is only indirectly related to the resistance of the material in that it represents that moisture content at which a given soil may be rolled into a thread of given dimensions without crumbling. The writer feels that it is unfortunate that the term "plastic limit" has been used to describe certain special conditions under which a soil may be manipulated, particularly when such conditions are not definitely related to limiting values of stress.

However, the term has gained wide usage in connection with the Atterberg tests, and perhaps it would be advisable to reserve it for that purpose. An investigation of current literature has convinced the writer that the term "yield point" or "yield value" is more often used in the connection in which the writer used plastic limit. Bingham[1] defines yield value as the minimum shearing stress required to produce continuous deformation in a solid. Various authorities define "yield point" or "yield value" as the stress which causes continued deformation without increased stress. The term is not generally restricted to shearing stress, but is used to designate similar behavior under all types of stress.

There are other examples of difficulties in soil-mechanics terminology which are even more important than the one under discussion and which should be mentioned. The writer uses the term "bearing capacity" to mean the load per unit of area at a given amount of settlement, and the term "bearing capacity limit" to represent the maximum load per unit which will be sustained without progressive settlement. While bearing capacity has been quite generally used in this connection, at least in American literature, there are a number of other terms also being used such as supportability, stability, subgrade modulus and plasticity.

Settlement has been defined[2] as the vertical movement of the bearing area, but one frequently sees the term "penetration" used in the same connection. This may lead to difficulty inasmuch as penetration is so widely used in a number of other types of tests.

Proctor uses plasticity in pounds per square inch to express the resistance to penetration of a needle or plunger into the soil. This may become particularly confusing because plasticity has been defined[1] as "that property which enables a material to be deformed continuously and permanently without rupture during the application of a force which exceeds the yield value." The more plastic a material is, the less applied force it will be able to sustain without progressive deformation. Thus the higher values of plasticity as expressed by Proctor actually mean that the material is less plastic according to definition.

The various investigators themselves are inclined to be careless because they are sufficiently familar with the subject to follow each other's work without confusion. But when it comes to adapting the results of research to general engineering practice, confusion is sure to result. Of course little progress toward standardization of terminology can be made until the fundamental principles have been fairly well established and most, if not all, of the controlling variables properly correlated. It does seem, however, that soil mechanics has progressed to a point where some representative organization could take over this assignment and bring order out of what will certainly be chaos within a few years. It is at the same time folly for several individuals to agree among themselves to adopt certain terms for certain things, as other independent workers may not be at all satisfied with the resulting nomenclature.

The American Society of Civil Engineers' committee "to codify present practice on the bearing value of soils" formulated a number of definitions[2] some years ago, but development in this field in later years seems to warrant additions and perhaps some revision at this time. Such attempts at standardization should recognize different points of view as regards fundamental principles in the process of development, otherwise they would be more liable to handicap development than to aid it. Therein lies the danger of standardization. While investigators must be allowed considerable freedom in selecting terms to describe the results of their research, it does seem that some guiding influence would be very valuable.

W. S. HOUSEL,
Assistant Professor of Civil Engineering, University of Michigan.

Ann Arbor, Mich., Nov. 13, 1935.

[1] "Some Fundamental Definitions of Rheology"—Bingham. *Proc.* A.S.T.M., Vol. 29, 1929.

[2] Progress Report of "Committee to codify present practice on bearing value of soils." *Proc.*, Am.Soc.C.E., February, 1921.

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December 12, 1935

Cooperative Waste Disposal

A NOTABLE APPROACH to the problem of cooperative industrial waste disposal is exemplified in Cedar Rapids, Iowa, where the local meat-packing company is sharing part of the cost of the new sewage plant in which have been incorporated separate pretreatment facilities for packing-house wastes. The question of industrial waste disposal is a fundamental issue in the growing agitation for abatement of stream pollution, and when these wastes are of such composition and volume as seriously to impair the normal efficiency of a municipal sewage-purification process it clearly becomes incumbent upon the industry involved to contribute its aid in correcting the condition. Arbitrary legislation directed toward strict regulation will not accomplish the desired result, for trade wastes are complex and differ so widely that each industry, and possibly each plant, presents a special problem. Only cooperative participation of industry and municipality can achieve a harmonious integration of purpose.

Surveys Under State WPA

NEW HOPE that some of the local control survey work on the Coast and Geodetic Survey network may yet be undertaken is found in the announcement made last week that the Works Progress Administration in Washington favors the carrying forward of such local work by the state WPA organizations or by other political subdivisions or municipalities. With the elimination of funds for such work from the federal WPA program (*ENR*, Nov. 14, 1935, p. 690), the opportunity to undertake this work as a local operation should be thoroughly explored. But the conclusion is inescapable that much less can be accomplished than would have been accomplished had direction of the work been continued in the C.&G.S. headquarters in Washington. That office did such a splendid job in organizing the emergency survey projects of 1933 and early 1934 that it could be counted upon to pick up the reins and get the work under way again quickly. Now separate drives must be made on state WPA administrators for approval of such work, and new men must be broken in to direct it. However, that is no reason why the attempt should not be made. The survey headquarters in Washington can still be counted on for advice in organizing state survey parties.

The Road Art Makes Progress

TECHNICAL ADVANCE in the road field is gratifyingly active. The discussions before the Highway Research Board at its meeting last week indicated a progressive attack on the problems of design and construction, and while most of the items of new knowledge brought forward represent refinement of detail rather than a breaking of new pathways they constitute progress of a kind essential to best road service at lowest cost. In particular the unremitting study that is being given to the substructure of the road is the researcher's response to urgent needs of the field. Service facts are showing with increasing force that the pavement, both body and wearing surface, is far ahead of the underlying foundation structure in its engineering development. Studies of soil stabilization, of moisture and frost phenomena or of fill failures, deal with widely felt weaknesses of the roadbuilding art. In due course it may be expected that fill consolidation and compacting will also receive closer scrutiny, since there are few road fills that do not lead the passing traveler to wonder if adoption of dam-building practice by the roadbuilder might not be a paying investment.

Traffic and Economics

RAILROAD HISTORY as seen from the vantage point of later days suggests that technique developed much earlier and faster than knowledge of sound railroad planning. The chief failures revealed by the record are those of project planning, not of line location or structural design. Trunks and branches that could be justified only in the promoters' prospectuses were built in great numbers, and this was due largely to the primitive state of knowledge of the business planning of railroad enterprise. The economics of both traffic and operation were much slower to be taken up than questions of grade and curvature, earthwork or track construction. There are indications that a similarly tardy development of economic study will make itself felt in highway history. Current research work, at any rate, is weakest on the economic side; even so imminent a question as traffic regulation, with its far-reaching economic implications and its bearing on highway policy and planning, was given scarcely a word in the Highway Research Board discussions. The complexity of the questions involved is some excuse for this condition, no doubt. Also, the study of economic principles is not so amenable to research procedure as is design and construction technique. But in the light of present facts it is safe to say that whatever research effort can be brought to bear on highway economics and adminstration will return large dividends.

Skyscraper Control

A PROPOSAL for a revision of the city zoning laws made by the Merchants' Association of New York contains an arresting suggestion pertaining to limiting the height and bulk of skyscrapers. Coming only a few years after the great American desire to build the tallest and biggest buildings in the world, the suggestion represents another of those extreme swings of sentiment caused by the depression. At the same time it echoes the views that many city planners have held for years, views which business men often granted were technically sound but unfortunately were not practical. If the membership of the Merchants' Association in a city noted as much for its tall buildings as anything else is now to reverse past trends, a significant change has indeed occurred. Both the merits and disadvantages of the proposal, whose fundamental purpose is to reduce population concentrations with their requirement for larger and larger transit facilities, are many and varied. Without going into the subject in detail it is pertinent to point out that strictly limiting building heights in relation to ground area will not necessarily solve this transportation problem. A much more likely solution of the problem is at

hand in another proposal, which advocates residential areas adjacent to business districts. Residential developments that would permit workers to live near their work not only would reduce the load on transit facilities but at the same time would remove many unprofitable and unhealthy slum areas. If lower transit cost is the end sought, the second zoning proposal would seem better than an attempt to control the size of skyscrapers.

Current Problems and First Principles

CONSTRUCTION, because it is primary in recovery as well as in our normal economic functioning, has a deep concern in the effort to set up collaboration of government and industry in solving our economic problems by an industrial conference under the leadership of George L. Berry, Coordinator of Industrial Recovery. It is most unfortunate, therefore, that the conference was shipwrecked at its beginning by a schoolboy quarrel. Industry's proper claim to a voice in deciding whether an employer-labor Industrial Council should be set up was steamrollered without being admitted to discussion, and the group conferences had to assemble without even a statement of the problems that they were supposed to consider. As a result, the cooperative effort is foredoomed to failure. Yet it is important to look at what has already been accomplished and at the work that remains to be done.

The construction group conference, though at first unwilling to present recommendations, thought better of the matter after discussion, and drafted a list of sound, strong proposals as a contribution to the recovery planning. The program, printed in the news pages of this issue, is a return to first principles. It rests on a foundation of minimum government participation in construction, free but healthy competition, local determination of wages and working conditions, and, finally, better organization of government construction—such as through a federal department of public works.

An equally important outcome of the meeting is the proof that NRA ideas are quite dead in the construction field. Even the possibility of setting up fair-practice agreements under the federal trade commission received no consideration by the construction group. At the same time the construction industry recorded its opposition to all schemes for injecting labor limitations into government contracts and thereby dividing construction into two divisions working under different rules.

In recognizing the value of the group's program one is bound to note that in the main it applies to normal-time conditions. We do not have such conditions today. The volume of construction is little over one-third normal, and as it can grow only gradually the return to regular practice is still some distance off. Two to three million construction workers are out of employment—contractors and engineers as well as workers. There is no question that the workers at least will be taken care of. This means, on the one hand, government work-relief or public-works activities, and on the other hand taxation or borrowing to defray the cost.

How to modify and supplement the program to deal with the still-continuing emergency conditions is for the delegates of the construction group to work out in their further deliberations. In addition, the discussions within the Industrial Council may bring forward some connecting links between emergency and normal-time conditions that sooner or later require attention; reform of construction financing has been barely begun, for example, and the problem of stabilizing employment is virtually untouched.

As we go forward in steady growth of construction toward its normal volume, and toward re-employment of its full quota of workers, such matters as these are certain to demand study. In the meantime the program of fundamentals drafted by the group affords a dependable guide to more complete development of construction policy.

Constructive Reorganization

FOR a good many years the pros and cons of bringing the major survey agencies of the federal government into a single integrated bureau have been under discussion among engineers. The thorough separation of topographic work from coastal surveys and geodetic control—the Coast and Geodetic Survey and the Topographic Branch of the Geological Survey are not only distinct bureaus but are in separate departments, respectively Commerce and Interior—furnishes the natural starting-point for such discussions. A tentative recommendation for their integration was made by the Science Advisory Board a year ago, following earlier proposals by others. On the basis of fuller study of the subject during the year, the board now reports definitely in favor of an integrated survey bureau.

The recommendation is eminently worthy of support. No substantial reason has ever been offered for continuing the division of our national surveys. Some organizational adjustment will no doubt be necessary, but it should present no real difficulty. Operations of such extensive kind and basic importance to private and public activities can never be efficient and well knit unless the responsibility for their direction is centered in one office.

It is only fair to say that, especially during recent years, there has been much better coordination of the geodetic and topographic surveys than might be expected under divided control. This favorable result is to a degree fortuitous, however; it is to be credited to the cooperative attitude of the organizations, and in part also to the influence of the Board of Surveys and Maps, which by serving as an agency of exchange and coordination has made the map service distinctly more useful to the country. But whatever has been accomplished under divided management, much more is possible under integrated direction.

One activity closely associated with surveys should not be slighted in the proposed survey unification. This is the water resources study which, like the topographic work, now is located in the Geological Survey. It is not primarily geological but engineering in its nature and purposes. The fact that stream and groundwater resources are today recognized as a vital element of the nation's physical assets justifies the twofold demand that the continuity and thoroughness of the water resource study be preserved, and that it be placed under engineering jurisdiction. Whether it is made part of the proposed survey bureau or is assigned to another engineering division of the government is not of critical importance. But if it were placed in an agricultural, scientific or commercial unit of the administrative structure, its future would be in jeopardy. Its preservation requires that it be made permanent part of a technical bureau.

CURRENT NEWS

Court Refuses To Enjoin New York In Sludge Dumping

THE U. S. Supreme Court, on Dec. 9, refused to enjoin New York City from dumping sludge from its sewage disposal plant into the sea, and stated that dumping of non-floating solids in the Atlantic Ocean, off the coast of New Jersey, did not constitute a violation of the decree handed down in 1933, prohibiting the dumping of garbage or refuse which would pollute the water and beaches.

New York City, on Oct. 7, 1935, filed a petition for modification of the decree to permit the dumping of sewage sludge consisting of about 90 per cent water and 10 per cent of finely divided solids which would not float. In its petition the city claimed that the amount of sludge that it dumped ranged between one-twentieth and one-sixth of the amount dumped in the same area by New Jersey municipalities. The city asked that New Jersey show cause why the petition should not be filed, and the court issued a show cause order returnable Nov. 18 (See *ENR*, Oct. 17, 1935, p. 552).

On Nov. 15 New Jersey consented to the filing of the petition and asked for the appointment of a special master to make findings of fact. The court held that the motion and returns of New Jersey were not sufficient to show that New York City had failed to comply with the decree. The motion for the appointment of a special master was denied, and New York was permitted to file its petition.

New Bids Asked for Midtown Tunnel Approaches

Bids for the construction of the Weehawken land sections and approach plaza of the Midtown Hudson Tunnel will be received on Dec. 19 by the Port of New York Authority. This is the second time that bids have been called for the New Jersey approach section, the first bids having been rejected in November when the Port Authority maintained that the bids received were in excess of the engineers' estimate of the cost of the work.

Under the new call for bids the work has been divided into three contracts, and bids will be accepted on each. One contract calls for construction of the rock tunnel section and another for the steel bent section and plaza, while the third contract includes all of the work contained under the other two. Contractors submitting bids for the one contract which covers all the work must also submit bids for the other two contracts.

The rock tunnel contract includes 785 ft. of rock tunnel west of King's Bluff, from the present ventilation shaft to the plaza portal. The steel bent section and plaza contract includes all of the open excavation work and the laying out of the plaza.

U. S. Supreme Court Acts In Arizona Water Suit

A Supreme Court order, in the case of Arizona against the states of California, Colorado, Nevada, New Mexico, Utah and Wyoming for equitable distribution of the Colorado River waters, on Dec. 9, required that these states show cause, within three weeks, why the Arizona complaint should not be filed. On Nov. 25, Arizona asked the court to make a judicial determination of an equitable distribution of the water. The present show cause order is a result of Arizona's petition for leave to file an original suit.

Gas Tax Diversion Contributory to Accidents, Contractors Hear

The diversion of gasoline and motor vehicle taxes to purposes other than road building is a contributory cause of the appalling toll of highway accidents, declared State Senator George R. Fearon, speaking before the annual meeting of the New York State Chapter of the A. G. C. at Albany Dec. 5. "While many excellent suggestions have been made to alleviate the accident situation," he said, "we must realize that there is one fundamental remedy. We shall continue to have an unnecessary number of accidents on our highways until we have a highway system which is adequate to meet the requirements of modern motor transportation.

"The tragedy of the situation is that those who are using the highways are paying sufficient money into the state treasury to build an adequate highway system, but their money is not being spent for this purpose. This diversion of highway money should be viewed as more than an injustice to a certain class of taxpayers. In its broader aspects it is causing New York state to lag far behind other states in the development of a highway system, and is basicly the cause in a very large degree of the increasing number of accidents."

Senator Fearon is chairman of the Legislative Highway Survey Committee, charged by the 1934 state legislature to make an exhaustive study of the design, construction, financing and use of the highways of the state and report to the 1936 legislature recommending changes in highway legislation. The committee held a public hearing at the convention, at which municipal engineers and representatives of civic associations made strong pleas for a share of the highway revenues to be returned to the cities and towns for street construction and maintenance.

In addressing the convention Charles M. Upham, director of the American Road-builders Association, declared that the nation can stand an annual highway program of $1,000,000,000, maintaining that gas tax and license revenues exceed $1,125,000,000 yearly. He said the highway safety programs now current require wider and safer roads to remove the driving hazards and bring the highways up to the demands of increased traffic.

Construction Presents Strong Program at Berry Conference

A PROGRAM of recommendations calling for elimination of government competition with established construction industry agencies and the utilization of the normal private channels of construction in federal work was drafted by the construction industry group which met at the industry conferences held at Washington, beginning Monday, Dec. 9, on the call of George L. Berry, Coordinator of Industrial Recovery. The group, numbering about 40, consisted of engineers, architects, general and special contractors, and trade association executives. Most of them attended as individuals, but a number came with limiting instructions from their associations.

The general session of the conference opened inauspiciously. Major Berry, who made the only address, restated and expanded his invitation to all interested parties to join in group conferences in order to develop industry cooperation with government in respect to recovery problems. He asked that a national industrial program in the interest of industry be framed by the conference, but was not specific as to the kind of problem or kind of program in question. He cited demands from certain industrial groups that increase of taxation be stopped, that the national budget be balanced and that governmental expenditure be reduced, and declared that the President is behind no man in desiring these objectives. But he pointed to over 11,000,000 now unemployed and more than 22,000,000 persons dependent on new employment, and said that to propose demands that will deprive these people of sustenance is to say something perfectly ridiculous.

As advance announcements of the conference had referred to the plan to establish an Industrial Council of management and labor, John W. O'Leary, of the Machinery and Allied Products Institute and former president of the U. S. Chamber of Commerce, took the floor at the close of Major Berry's address to inquire about the Council plan. Without permitting him to continue, Chairman Berry declared the meeting adjourned, and the session shortly broke up in wild disorder after he had charged industry representatives with trying to break up the conference.

The 44 industry groups designated by the program for the conference then assembled in separate meeting rooms. Many of the sessions were attended by only three or four participants, however, and most of them adjourned without appointing delegates to the proposed Industrial Council, which, as it appeared by this time, had been definitely decided upon by the Coordinator.

The construction group organized by naming William Stanley Parker, architect, of Boston, as chairman, and Lawrence Mehren, assistant secretary of the Construction League, Washington, as secretary. Extended discussion of points to be

included in a program of construction industry revival followed. Later the meeting named a committee of five to draft a program of recommendations to be submitted to the Coordinator and to the Industrial Council.

In the evening session of the group, the program prepared by the committee was reviewed in detail and was adopted. It contained the following eight recommendations:

1. That federal competition with construction industry agencies cease, and that the federal departments utilize the normal private channels of construction.
2. That a declared federal policy be established in which the construction industry will have confidence. The lack of confidence between this industry and the administration is chargeable to such action as governmental disregard of NRA code principles; to the fact that relief wages have in many cases equaled or exceeded those in private construction, contrary to expressed intentions; and to the elimination of useful projects through destructive federal restrictions.
3. That encouragement be given to local determination of fair construction industry practices and labor relations.
4. That the threat of pending legislation which would further undermine the construction industry, such as the proposed Black Bill, the proposed Walsh Bill, etc., be removed.
5. That federal construction programs be coordinated through a single competent federal works department sympathetic to private enterprise; that permanent committees on construction be established in the Senate and in the House.
6. That federal financial aid to state, county and municipal works projects be reduced as soon as communities can initiate and finance them according to normal practices.
7. That investment of private capital in construction be encouraged through income tax legislation permitting deductions from gross income of amounts invested in construction projects for a period sufficient to re-establish a normal market.
8. That in the interest of sound recovery, which involves the revival of private industry, the present government departmental policy of assuming functions which are normally those of industry, be terminated at once.

The letter embodying the program further stated: "If the principles as above stated are adopted, confidence will be restored, private financing of construction will be resumed, and the construction industry will be in a position to absorb its unemployment roll. A continuation of the present trend toward the socialization of construction functions, design and execution will so disrupt private enterprise in construction that an increased burden of public relief must be anticipated."

After approval of the program, the conference continued the committee in office as a group of delegates to the Industrial Conference, to represent the five branches of construction recognized in the conference program: building, highway, subcontracting, heavy construction and professional. The delegates are Fred Rowe, John Dewar, A. E. Horst and Carlton S. Proctor.

Central Valley Funds Reallocated Allowing Use of Revised Plans

(Washington Correspondence)

REALLOCATION of $14,000,000 to the Bureau of Reclamation to initiate the Central Valley Conservation project in California was announced by Secretary Ickes, Dec. 10. Of the original $15,000,000 allotment, $1,000,000 was not affected by the change. The purpose of withdrawing and reallocating the money was to enable the Bureau of Reclamation to proceed with construction on a more feasible plan developed by the bureau's engineers and approved by President Roosevelt at the request of Senator Johnson (*ENR*, Nov. 21, 1935, p. 727).

The new work schedule has also been approved by Comptroller General McCarl. Dr. Elwood Mead, Commissioner of Reclamation, said work would begin on several engineering features of project in near future. The bureau has completed plans and specificiations for the initial contracts and bids will be opened almost immediately.

Under the terms of the original allotment, the money was to have been used in construction of Friant Dam on the San Joaquin River and the canals leading from it to areas in southern San Joaquin Valley where the underground water supply either has been or is being exhausted and where highly developed farms have been abandoned.

First plan uneconomical

"Since the Central Valley project is a well-integrated conservation plan, designed at a cost of about $1,000,000 to the state of California and the federal government," Commissioner Mead said, "it was found to be uneconomical to break it down for the purposes of construction into component parts. The effectiveness of the San Joaquin Valley phase of the project is dependent upon concurrent construction of the Sacramento River storage dam."

Under the provisions of the reallocation the bureau is empowered to proceed in what it considers the most economical manner of constructing the project, subject only to a limitation which prohibits encumbering by contract funds in excess of the $15,000,000 which now is available for the work. Dr. Mead said Walker R. Young, construction engineer in charge of the project, L. N. McClellan, electrical engineer, and J. L. Savage, chief designing engineer of the bureau, had submitted a tentative plan for construction. Under this plan the allocation would be spent as follows: Excavation and preparation for building Kennett Dam on the Sacramento River, $500,000; construction of Contra Costa Conduit Canal, $2,500,000; purchase of water rights in San Joaquin Valley, $2,000,000; construction of Friant Dam on the San Joaquin River, $3,500,000; beginning construction on the Madera Canal $500,000; beginning construction of the Friant-Kern Canal, $1,000,000.

"Upon further study," Commissioner Mead said, "it may be found advisable to revise somewhat the amounts of the different items in the tentative plan, but at present there seems to be no better choice of features to be included in the initial construction and no necessity to change materially the amounts allotted to the various features."

The two primary purposes of redistributing the waters of the Central Valley are to prevent encroachment of salt water from San Francisco Bay upon the rich lands of the Sacramento-San Joaquin delta and to provide a supplementary water supply to lands in southern San Joaquin Valley. In addition a fresh water supply will be provided the industrial cities on Suisun Bay where encroachment of salt water presents a serious threat to large developments, and hydro-electric power will be generated for the northern California market. Regulation of the Sacramento River also will assist in controlling the floods of that stream and improve navigation on the rivers.

Beach and Shore Erosion To Be Discussed in Washington

Coastal erosion problems will be discussed in Washington, Dec. 16, at the annual meeting of the American Shore and Beach Preservation Association. Talks will be given outlining contractor's and constructor's views on coastal and marine structures intended for checking erosion; physiographic aspects of Atlantic coast beaches, and legislative aspects of coastal protection. There will be a forum session on the best methods for advancing legislation to secure federal financial assistance for preventing waterfront property destruction and Col. Earl I. Brown, chairman of the U. S. Beach Erosion Board, will review the wave tank studies made by the Corps of Engineers.

New Zoning Law Recommended For New York City

Demand for a revision of the zoning laws of New York City has been made by The Merchants' Association, upon the recommendation of its committee on building laws and regulations.

That there is need for a new zoning resolution which will eliminate the present inadequacies and provide logical development of future building operations in Greater New York was pointed out by John Lowry, chairman of the committee, who also stated that proper zoning is necessary for real estate. He further held that proper planning would avert the need for endless rapid transit lines to take care of a population that is too highly concentrated.

There has been for years a race to see who could build the tallest building, and, according to Mr. Lowry, very little thought on whether those skyscrapers were a desirable addition to the city as a whole. There should be greater open spaces; more air and more sunlight. There is no reason why the people working in Manhattan should be obliged to go to Queens to find adequate housing, he added, and when an industrial center is placed in Manhattan room should be provided, relatively near to the industrial site, for the homes of those who will work there.

PWA Approves Contract For Engineering Work at Buffalo

With the approval, on Dec. 6, by PWA of the contract of the Buffalo Sewer Authority, Buffalo, N. Y., with Greeley & Hansen as engineers for the project, work is expected to get under way before the date of President Roosevelt's deadline. The contract was approved following a modification which requires the consent of the PWA to any dismissal of the engineers. A strong fight was made for this provision in order to take the construction of the sewer away from possible political influences. The contract allows $378,000 fees for design and supervising construction and inspection of the $10,500,000 major portion of the contract, and a $3,000 flat fee for similar work in connection with the $2,100,000 Bird Ave. and Michigan-Masten storm drains, the preliminary work on which has already been done by the public works department of the city.

Bids will be received by the engineers Dec. 14, for the drains on the Michigan-Masten part of the project, the cost of which is estimated at $50,000. Plans for this have the approval of the engineers and of Harold Epstein, Public Works Administration project engineer.

The United Taxpayers League of Buffalo submitted an affidavit, which was not made public, to Governor Lehman on Dec. 4 and requested an investigation of the original letting of the contract. On Dec. 7 Gov. Lehman made public the following letter to the taxpayers league:

"I beg to acknowledge receipt of your letter of December 4th inclosing an affidavit by Mr. Joseph H. Acheson, the Buffalo representative of the engineering firm of Fuller & McClintock, protesting that his firm was not selected as the engineers for the Buffalo Sewer Authority in the execution of a sewage disposal system financed by the Public Works Administration.

The public press indicates that you have addressed a communication to Honorable Harold L. Ickes, Public Works Administrator at Washington, asking him to withhold approval of the appointment of the engineering firm of Greeley & Hansen. In view of the fact that the financing of the project as well as the terms and conditions of all contracts and agreements relating thereto come under the authority and jurisdiction of Mr. Harold L. Ickes, Federal Public Works Administrator, I am returning to you Mr. Acheson's affidavit so that you may submit it to Mr. Ickes if you so desire.

Yours very sincerely,
HERBERT H. LEHMAN."

Two Water-Power Plants Proposed in Eastern Canada

The City of Sherbrooke, Quebec, is planning a 9,000-hp. extension to its municipal water power system, through a development at Two Miles Falls, near the city. A report on the project has been ordered from A. C. Crepeau, consulting engineer of Sherbrooke. The capacity of the existing plant is already overtaxed and consumption is steadily increasing.

Bids are expected to be called in the near future for a new water power plant to serve Noranda Mines in the northwestern part of the province of Quebec.

SOCIETY CALENDAR

NATIONAL RIVERS & HARBORS CONGRESS, special meeting, New Orleans, La., December 13-14.

NATIONAL ASSOCIATION OF HOUSING OFFICIALS, annual meeting, New York, December 14.

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, annual meeting, Washington, D. C., December 16.

AMERICAN ENGINEERING COUNCIL, annual meeting and conference of Secretaries of Engineering Societies, Washington, D. C., January 9-11, 1936.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual meeting, Miami, Fla., January 13-15, 1936.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, January 15-18, 1936.

AMERICAN ROAD BUILDERS' ASSOCIATION, annual convention and road show, Cleveland, Ohio, January 20-24, 1936.

CONSTRUCTION EQUIPMENT ASSOCIATION, first annual meeting, Cleveland, Ohio, January 20-24, 1936.

CANADIAN CONSTRUCTION ASSOCIATION, annual meeting, Hamilton, Ont., January 21-23, 1936.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Columbus, Ohio, January 29-31, 1936.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, Pittsburgh, Pa., March 4, 1936.

NEW YORK BUILDING CONGRESS, luncheon meeting; Eugene Meyer, guest speaker, New York City, December 18.

METROPOLITAN SECTION, American Society of Civil Engineers, New York City, December 18.

NEW YORK SECTION, AMERICAN WATER WORKS ASSOCIATION, midwinter meeting, New York City, December 27.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual meeting, Atlantic City, N. J., February 12-14, 1936.

SOUTHWEST ROAD SHOW AND SCHOOL, Wichita, Kan., February 25-28, 1936.

EXAMINATIONS for registration of professional engineers will be held in the near future, as follows:

MICHIGAN—Examinations for registration of Architects, Engineers, and Land Surveyors by the Michigan State Board of Examiners for the Registration of Architects, Engineers and Surveyors will be held December 26-28, 1935. Examinations for architects at the University of Michigan; for engineers and surveyors at University of Michigan, Michigan State College and Ironwood.

Buzzard's Roost Case Returned for Retrial

The U. S. Circuit Court of Appeals, sitting at Baltimore, on Dec. 5 sent back for retrial the case challenging a PWA loan and grant of $2,852,000 to Greenwood County, S. C., for the production and distribution of hydroelectric power. This action was taken following the government's plea that a new contract between PWA and the county should be considered by the original trial court, the U. S. District Court for the Western District of South Carolina.

The original action, brought by the Duke Power Co. and the Southern Public Utilities Co., was decided Aug. 10, 1935, when Judge Watkins granted an injunction in favor of the complainants. An appeal was taken shortly thereafter by the government. The project comprises a dam 85 ft. high and 2,000 ft. long at Buzzard's Roost on the Saluda River, together with an initial generating installation of 15,000 kw. and a distribution system.

Willacy Irrigation Loan Approved By the PWA

Final approval has been given by the Public Works Administration of the application of the Willacy County Irrigation District for a loan of $4,583,000 for the construction of a system of canals and laterals for the irrigation of 75,000 acres of land in the outer section of the Lower Rio Grande Valley. Funds for the project are expected to be released soon and engineers appointed.

In March charges of conspiracy to defraud the federal government were made against men connected with the district. Indictments were returned in Washington, but these were later dismissed and a new board of directors of the district was appointed (*ENR*, Mar. 28, 1935, p. 465).

The water supply for the district will be obtained from the Rio Grande River and carried 40 miles through a main canal to a large natural storage reservoir from which it will be pumped into lateral canals as needed.

Yarnell Explains Limitations Of Rainfall Intensity Data

To make the application of rainfall intensity-frequency data more valuable to engineers, additional information is needed on runoff from watersheds and on time or duration of concentration from storms, D. L. Yarnell, senior drainage engineer, U. S. Bureau of Agricultural Engineering told members of the American Society of Agricultural Engineers at their midyear meet in Chicago, Dec. 4. Mr. Yarnell explained that if the proper runoff for a watershed is known and the time or duration of concentration, with the use of intensity-frequency charts, a flood-frequency curve for it can be charted.

The maximum discharge to be expected from any watershed for a given frequency will occur only when the storm over the entire area is of a duration sufficient that all parts of the watershed are contributing to the flow at the outlet, and this duration or time of concentration must be determined for a watershed before the intensity charts can be used. In making computations such data is not always available and the time it takes for water to travel from the remotest part of the watershed to the point at which it is desired to determine the amount of runoff is computed. Such computations require a knowledge of the sizes, shapes and topographies of watersheds. The time of concentration for a given watershed is not necessarily a constant, Mr. Yarnell pointed out, but may vary to some extent depending upon the season of the year, vegetation, and other factors. If the runoff coefficient for a watershed is known, and the time of concentration, a flood-frequency curve can be prepared. After computing from the intensity charts the maximum discharges for frequencies of 2 to 100 years, these values may be plotted with frequencies as absicassa and discharges as ordinate and a flood-frequency will be obtained. Records of actual discharges from small areas usually are not of sufficient length to prepare a reliable flood-frequency curve by the probability method. Only as the length of rainfall records approaches 100 years will the correctness of the charts be revealed.

Building Trades Agree on Jurisdictional Dispute Settlement

Means of a settlement of jurisdictional disputes between the various building trades unions were established on Dec. 4, when representatives of nineteen unions met in Washington, D. C., and decided upon a plan for submitting questions of jurisdiction to a referee.

The plan provides for a federal district court judge to act as referee in cases where the unions cannot agree as to which has jurisdiction. Before the federal district court is called upon to act as referee, however, the contractor on the job is to act as arbitrator and decide which union is to do the work, and if the decision fails to satisfy both parties the case is appealed to the court, but the work continues meanwhile, as designated by the contractor.

Detroit Incinerator Bids Held Unopened by Court Action

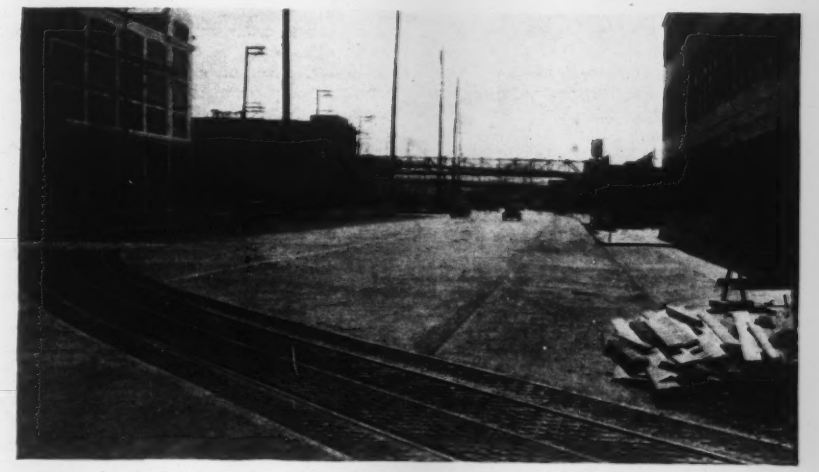
Litigation has prevented Wayne County, Mich., from opening the bids for four large incinerators in Detroit, received on Dec. 4 (*ENR*, Nov. 28, 1935, p. 761). Among allegations of the opponents to the opening of the bids was one claiming that PWA regulations called for an unwarranted delegation of authority. Four bids were received. The bidders were: Hiler Engineering Co., Brooklyn, N. Y.; Decarie Incinerator Co., New York City; Rust Engineering Co., with C. O. Bartlett & Snow Co., Cleveland; Pittsburgh-Des Moines Steel Co., Pittsburgh. Certified checks that were submitted by the bidders have been returned to them. When the present litigation is ended either a redeposit of the checks will be asked, or else the bids will be returned and new bids invited. L. G. Lenhardt is consulting engineer for the board of auditors of Wayne County, and commissioner of public works of Detroit.

Platte Valley Power District Begins Filling of Reservoir

The diversion dam across the North Platte River, near Keystone, Nebr., was closed, and water diverted through the 45-mile canal leading to the reservoir of the Platte Valley Public Power & Irrigation District at Sutherland on Dec. 2.

This is the first step toward operation of the $7,500,000 hydroelectric power and irrigation project which is being constructed with PWA funds. About 100 sec.-ft. of water is being turned into the canal at present, and it is estimated that it will take about ten days for the water to reach the reservoir, which in turn will take about three months to fill. Completion of the powerhouse is expected by the middle of March, and actual production of power will begin shortly thereafter. The Keystone diversion dam is about 10 ft. high and 1,500 ft. long, and impounds a lake of about 11,000 acre-ft. The Sutherland project combines a storage of 146,000 acre-ft. of water, and a 34,000-hp. power plant.

At present PWA and Bureau of Reclamation engineers are studying the feasibility of coordinating the three Nebraska power projects, Platte Valley, Tri-County and Central Nebraska.



SEATTLE WATERFRONT RECONSTRUCTION COMPLETED

Reconstruction of more than a mile of Railroad Ave., Seattle, begun nearly two years ago, was completed late last summer. The work included tearing out the old sea wall and timber structures carrying the street and railway lines, the construction of a new sea wall of reinforced concrete, construction of a timber relieving platform behind the wall to carry the fill upon which the pavement and track to the waterfront structures are laid, and repaving the street. This project was described in *ENR*, Nov. 8, 1934, p. 579. A preliminary to the work was the signing of new franchise agreements with the railroads which restricted their use of the 150-ft. street to the easterly side, leaving only spur connections across the main roadway. The accompanying photograph shows the reconstructed street with its new pavement on the westerly side.

At the easterly side of the street, the tracks are laid in the open; where the spur tracks cross the new pavement cast iron crossing plates are installed. The improvement has materially increased the traffic capacity of the street.

Committee To Investigate Gila Valley As Contract Bids are Returned

(Washington Correspondence)

APPOINTMENT of an independent committee to investigate the ability of the proposed $23,000,000 Gila Valley reclamation project to support a farming population was this week's sequel to Secretary Ickes' sudden order suspending all survey work and construction. The order was issued the day before the Yuma, Ariz., office of the Bureau of Reclamation was scheduled to open bids, which were received on Dec. 2, for earthwork and tunnels on the main canal. As a consequence bids were returned to contractors unopened. An allotment of $2,000,000 from relief works funds previously had been made to the Bureau of Reclamation to initiate the project this year.

Unsuited for Agriculture

The action taken by Secretary Ickes was prompted by a letter from Secretary of Agriculture Henry A. Wallace to President Roosevelt representing that the Gila Valley area is not fit for human habitation and that the soil is lacking in sufficient humus to produce ordinary crops. With respect to the production of grapefruit as a major crop, Secretary Wallace contended that planting more orchards was not warranted in view of constantly increasing production in western Texas and other regions.

A survey of Gila Valley by officials of the Resettlement Administration which led to intervention by Secretary Wallace is said to have been inspired by complaints of local interests in Arizona but the news that all work on the project had been suspended was received with indignant protests. Until it was learned that the Department of Agriculture was instrumental in blocking the project, the Reclamation Bureau was charged with acting in bad faith, having previously prevailed upon the state to withdraw its objections to construction of Parker Dam. Senator Hayden had failed in an attempt to persuade Undersecretary of Agriculture Tugwell not to pursue the matter as the Bureau of Reclamation was satisfied that the project is justified from human, economic, agricultural and engineering aspects and was ready to undertake construction.

Three-man committee

The action forced on Secretary Ickes was not influenced by any thought of retaliating against the state of Arizona for recently bringing suit in the U. S. Supreme Court attacking the distribution of waters as established by the Colorado River compact which preceded construction of Boulder Dam. The committee appointed by Secretary Ickes to establish the facts in dispute by the Reclamation Service and the Resettlement Administration concerning justification for the Gila Valley project is composed of W. H. Code, of Quinton, Code & Hill—Leeds & Barnard, consulting engineers of Los Angeles; Prof. William Peterson, of Utah State Agricultural College at Logan; and Cecil Creel, director of the Nevada state agricultural extension service, Reno.

Obituary

WALTER V. CRANFORD, head of the Cranford Co., engineers, Brooklyn, N. Y., died at his home in Greenwich, Conn., on Dec. 6.

HENRY SWENSON died at his home in Center City, Minn., on Nov. 23 at the age of 78. Mr. Swenson was born in Center City and spent a good many years in railroad engineering and was chief engineer of the St. Paul & Duluth R.R. prior to its acquisition by the Northern Pacific Ry., when he became assistant engineer of the Northern Pacific. He later moved to Duluth and accepted an engineering position with the U. S. Government. Prior to 1915 Mr. Swenson entered private practice doing county engineering work in Chicago, Sandstone and Pine counties.

CHARLES H. EWING, president of the Reading Co. and the Central Railroad of New Jersey, died at his home in Melrose Park, Pa., on Dec. 8. He was 70 years old. Mr. Ewing began his railroad career at the age of 17 as a rodman on the Philadelphia & Reading R.R. in 1883, after graduating from high school and being privately tutored in civil engineering. He later became assistant engineer and supervisor for the Reading and then went with the Central New England Ry. as division engineer in 1892 and later was made chief engineer. In 1902 he returned to the Reading as division engineer. He was made maintenance of way engineer in 1903 and five years later, superintendent of the Atlantic City Ry. He then became general superintendent, general manager, and vice-president, successively, of the Philadelphia & Reading Ry. Co. He became president of the Reading in 1932 and of the Jersey Central in 1933.

CONSTRUCTION STATISTICS OF THE WEEK

ENGINEERING construction awards total $35,037,000 this week, which is made up of private work, $4,077,000, and public, $30,960,000, of which $2,388,000 is federal and $28,572,000 state and municipal. This is lower than last week in all classifications. Corresponding values last year are: total, $28,858,000; private, $4,799,000; public, $24,059,000; federal, $1,979,000 and state and municipal, $22,080,000.

Sewerage awards are higher than last week but all other classes are lower. The totals are: waterworks, $3,398,000; sewerage, $4,541,000; bridges, $1,025,000; streets and roads, $9,306,000; public buildings, $7,764,000; commercial buildings, $1,180,000; industrial buildings, $725,000; earthwork, waterways, $2,961,000.

The larger awards for the week include: school, Troy, N. Y., $510,000; high school, Savannah, Ga., $555,000; highways, by Virginia, $700,000; by Georgia, $578,000; by Montana, $741,000; by Oregon, $513,000; by Texas, $622,000; bridges, by Montana, $382,000; watermains in various streets, relief labor, Buffalo, N. Y., $2,094,000; Southern Arsenal Public Relief Sewers, Sect. 1 and Joint Relief Sewer District, two contracts, St. Louis, Mo., $1,238,000; intercepting sewers, contract 1, plumbing contract 4, heating and ventilating, contract 5, electrical work, contract 6, Niagara Falls, N. Y., $880,000; two generators for Boulder Dam, Boulder City, Nev., $1,301,000; 85-mi. pipe line for Continental Oil Co., Oklahoma, $1,000,000.

State and municipal bond sales were heaviest since April. New issues totalled $14,157,000 and purchase for private investment from RFC totalled $8,800,000 more. Corporate security issues totalled $9,280,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Dec. 1934	Prev. 4 Weeks	Week Dec. 12 1935
Federal Government	$3,979	$4,507	$2,388
State and municipal	15,399	30,359	28,572
Total public	$19,378	$34,866	$30,960
Total private	5,977	8,041	4,077
Week's total	$25,355	$42,907	$35,037
Cumulative to date:			
1934	$1,314,273,000	1935	$1,439,027,000

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

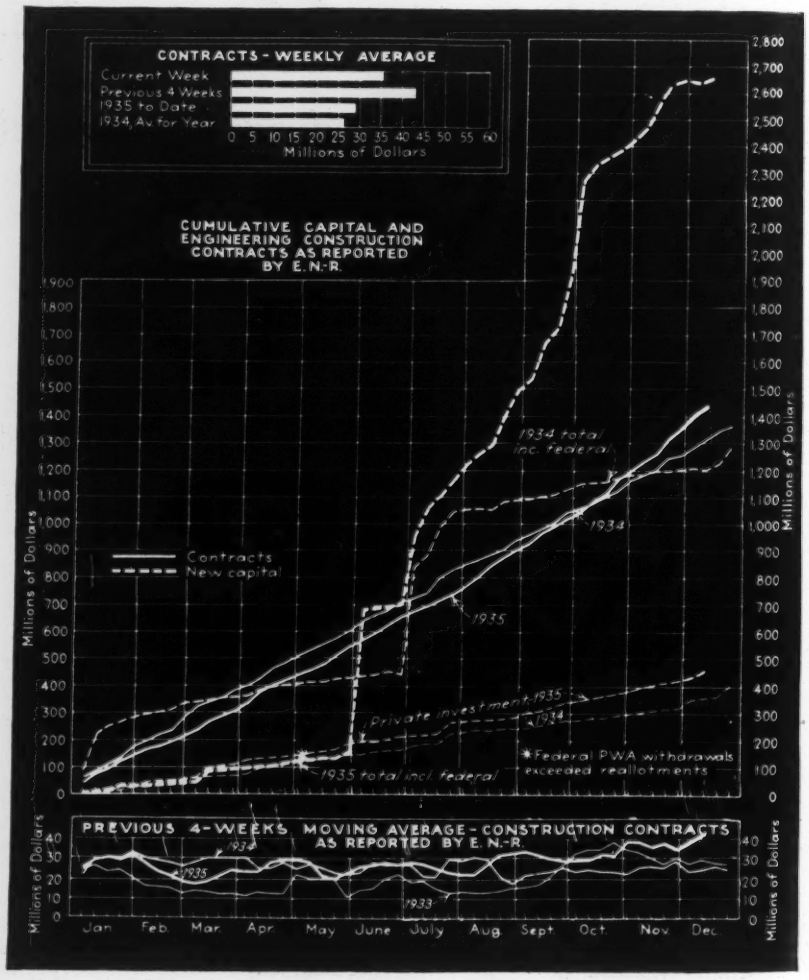
1935	Week Dec. 12	Cumulative
State and municipal	$22,957*	$431,310*
PWA allotments, S&M	738	761,478
RFC loans, S&M	—8,800*	39,380*
Corporate issues	9,280	37,018
PWA private	....	9,086
Local contrib. to WPA	....	31,861
Total non-federal	$24,175	$1,310,133
PWA federal	49	1,349,528
Total new capital	$24,224	$2,659,661
Cumulative to date:		
1934	$1,204,335,000	1935	$2,659,661,000

*Includes transfer from federal to private through sale by RFC of PWA bonds.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 =100	1926 =100	ENR Volume	1913 =100	1926 =100
Dec., 1935	**194.90**	**93.69**	**Nov., 1935**	**171**	**75**
Nov., 1935	194.90	93.69	Oct., 1935	162	71
Dec., 1934	201.86	97.00	Nov., 1934	98	43
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.89	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1935 to Date
1934, Av. for Year
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
Millions of Dollars
1934 total incl. federal
1934
1935
Contracts
New capital
Private investment-1935
1934
1935 total incl. federal
*Federal PWA withdrawals exceeded reallotments
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E. N.-R.
1934
1935
1933
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec

Construction Equipment and Materials

Cross-Field Generator Aids In Better Welding

A new control principle, for arc welding sets, giving a practically constant current volt-ampere curve and excellent transient characteristics has been perfected by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., after several years of research. Operating on a cross-field generator scheme these sets increase the range of electrode sizes and thickness of materials welded, are convenient to operate and are safe in operation due to low open circuit voltages.

This new generator has only two poles, four field coils and four brush arms. A number of other parts such as the exciter, brush shifting devices, reactor, meters, rheostat and resistors are eliminated.

Giving as it does a practically constant welding current not only on the volt-ampere curve but also during transient changes, this generator improves the quality of the welds. This new set has only 2 kw. no-load input. A greater percent of the electrode melted is put in the weld, giving the electrode a higher deposit efficiency. Because of this greater deposit efficiency and because the arc is easy to hold the operator is able to weld faster.

A hand wheel on the side of the set may be turned to adjust for any desired current, and the current for which the machine is set is indicated by a dial geared to the handwheel. Also built into the side of the generator frame is a polarity reversing switch for instantly reversing the relative polarity of the electrode and ground leads. It is possible to use either 1/8 or 3/8 in. electrodes with a 400 amp. generator. The continuous mechanical current adjustment makes it possible to set for precisely the welding current desired.

New Mammoth Excavator For Coal Stripping

The first of the new 30-yd. power shovels built by the Bucyrus-Erie Co., South Milwaukee, has recently been put into service by the Binkley Coal Co. on coal stripping operations near Terre Haute, Ind. The machine has a boom 105 ft. long, a dipper stick 64 ft. long, a maximum dumping height of 70 ft., a cutting radius of 115 ft., and a dumping radius of 106 ft.

The operator of the machine has a control cab at the height of a three-story building in which are the controls for 32 electric motors used in the various operations. These motors range in size from 3/4 hp. to one of 1,000 hp. which drives the four main generators.

The 950-B is available as a shovel or as a dragline, and is fully convertible for use with either type of equipment.

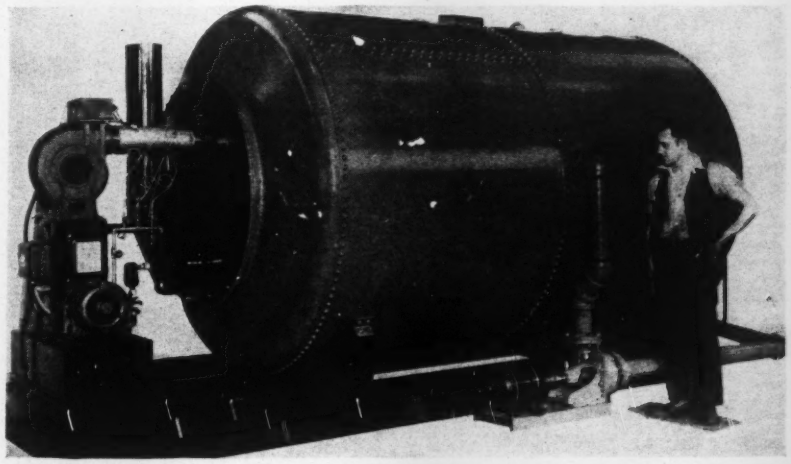
Stabilized Road Materials Mixed By Portable Plant

A portable plant designed to prepare and mix materials used in a soil-stabilized road has been announced by the Pioneer Gravel Equipment Mfg. Co., Minneapolis, Minn. The stabilized plant eliminates the uncertainty arising from the lack of accurate control of the ingredients used in preparing a road under the usual method of mixing ingredients with blade graders.

The stabilizer plant is a one-unit outfit mounted on a four-wheel steel truck. The plant is equipped with a clay feeder, belt conveyor, clay shredder, pugmill, calcium chloride hopper and feeder, and a delivery conveyor. Gravel is crushed and screened in a separate plant and delivered directly to the pugmill. Mix control is assured as the clay is dumped through a trap onto a special type feeder which governs the amount of clay fed to the plant. A belt conveyor delivers the clay to a shredder which tears up the chunks. A roll crusher can be provided if necessary to crush rocks and flatten out the clay. The clay is then dropped into the pugmill with the gravel.

Calcium chloride is fed from a hopper through an automatic feeder which controls the amount of calcium chloride. Water is added as may be necessary in order to get the desired moisture content. The pugmill thoroughly mixes and blends the ingredients and deposits the stabilized gravel on a belt conveyor for delivery to trucks or bins where it is stored until surfacing operations are begun.

The material can be delivered directly onto the prepared grade and requires only spreading and rolling in order to make a finished wearing course.



HOT WATER HEATER FOR WINTER CONCRETING

A compact, oil-burning hot water booster for raising water to required temperatures for winter concreting.

Standard units are built, by the Cleaver-Brooks Co., Milwaukee, Wis., in sizes delivering 800 to 3,200 gal. per hour at a temperature raise of 150 deg. F. These hot water boosters are automatically operated from an aquastat to deliver water at any required temperature. They require no licensed operator nor expensive settings and occupy a small space on the construction site.

New Equipment In Brief

Welding Manual. ARC WELDING, ELECTRODES & ACCESSORIES is the name of a new booklet published by the Lincoln Electric Co., Cleveland, Ohio. The book, which is 8½x11 in., has 64 pages and explains the procedure for making welds with various types of electrodes.

Lithoform. A new chemical compound developed by the American Chemical Paint Co., Ambler, Pa., is used to secure a lasting bond between galvanized iron and paint. Lithoform is either brushed or sprayed on the galvanized surface and forms a hard coating which prevents the formation of zinc soaps, which would occur if the oil paint came in direct contact with zinc oxides and carbonates which form on galvanized surfaces.

New Wiring Strip. A product, trade marked "Plug-In" Strip, designed to add safety and convenience to electric installations has been announced by the National Electric Product Corp., Pittsburgh, Pa. It consists of a 1⅜ in. zinc treated channel with a bakelite cap which has plug openings every 6 in. It is made in ready-to-install units of from 1 to 5 ft. long.

Roofing Booklet. A 52 page booklet, FACTS ABOUT ROOFING, is being distributed by the Flintkote Co., New York City. It is issued primarily as a sales manual for distributors and their representatives, but also is a guide book to the processes used in making asphalt roofing. The booklet was prepared as a sales manual and as a practical portfolio for use in direct sales work.

New Publications

KOEHRING HEAVY DUTY CONSTRUCTION MIXERS, Koehring Co., Milwaukee, Wis. 8½x11, 12 pages.

ENGINE TYPE GENERATORS, Allis-Chalmers Mfg. Co., Milwaukee, Wis. 8½x11, 23 pages.

AUTOMATIC ARC WELDING, Lincoln Electric Co., Cleveland, Ohio. 8½x11, 40 pages.

COTTON FARM-TO-MARKET ROADS, Cotton-Textile Institute, New York City. 6x9, 12 pages.

INDEX TO BRISTOL'S RECORDING AND CONTROLLING INSTRUMENTS, The Bristol Co., Waterbury, Conn. 8½x11, 8 pages.

DOUBLE SUCTION CENTRIFUGAL PUMPS, Lawrence Machine and Pump Corp., Lawrence, Mass. 8½x11, 4 pages. Bulletin 201.

CHAMPION SNOW PLOWS, Good Roads Machinery Corp., Kennett Square, Pa. 8½x11, 59 pages.

THE IMPROVED REVOLUTE 3E, Paragon-Revolute Corp., Rochester, N. Y. 8½x11, 4 pages. Continuous automatic blue printing machines.

Current Construction Unit Prices

Peoria Lock, Illinois River

A LOCK, 110x600 ft., and a 1,050-ft. movable dam are being built on the Illinois River 4½ miles below Peoria, Illinois. The overall length of the lock and guide wall masonry is 1,937.5 ft. The work includes an esplanade fill upon which lock tenders' residences will be constructed, and a 20-ft. top gravel approach roadway 4,000 ft. long. Bids for the project were opened Oct. 22, 1935, in the U. S. engineer office, Chicago, Ill. Lt.-Col. D. H. Connolly, District Engineer, is in charge of operations. PWA minimum hourly wage rates of $1.20 for skilled and 50c. for common labor prevail. The specifications require that the contractor obtain all timber piling and cribbing directly from the forest with forces engaged solely on the operation under contract, although such work may be sublet under the same conditions applying to the general contractor. Similarly all aggregate materials must be obtained from the quarries and pits. Undeveloped gravel deposits are believed available within reasonable distance from Peoria, although contractor may bargain with existing commercial plants and provide labor only for producing the aggregates. It is also required that hand labor only be employed in the construction of the esplanade and roadway. Completion is scheduled for 375 days after contract award.

The unit bids and totals of the three low bids follow: (A) Great Lakes Dredge & Dock Co., Chicago, Ill., $1,654,593 (contract); (B) Merritt-Chapman & Whitney Co., Cleveland, O., $1,773,537; (C) United Construction Co., Winona, Minn., $1,793,793.

PEORIA LOCK ON ILLINOIS RIVER

	A	B	C
1. Cofferdam—1,437.5 lin.ft	$250.00	$220.00	$222.90
2. Clearing—19.1 acre	90.00	125.00	148.93
3. Excavation, common—300,600 cu.yd	.33	.47	.43
4. Fill, backfill—49,600 cu.yd	.70	.10	.52
5. Fill, esplanade—108,000 cu.yd	1.87	1.20	.74
6. Piling, round timber—222,000 lin.ft	.56	.64	.60
7. Piling, round timber test—400 lin.ft	1.62	1.50	2.55
8. Piling, steel sheet—76,050 sq.ft	1.07	1.40	1.19
9. Pile load test—5, each	337.20	800.00	480.14
10. Timber, common cribbing—261 M.B.M	81.35	127.00	109.90
11. Stone, derrick—1,760 cu.yd	4.87	7.00	7.97
12. Stone, riprap—4,470 cu.yd	1.66	6.00	5.96
13. Stone, gravel—100 cu.yd	3.99	5.00	7.28
14. Gravel road surfacing—9,900 sq.yd	1.14	2.00	1.47
15. Concrete, Cl. A—4.6 cu.yd	12.40	30.00	44.68
16. Concrete, Cl. B—64,100 cu.yd	9.10	11.00	12.73
17. Steel, struct. wall armor—426,000 lb	60.00	70.00	60.00
18. Steel, struct. misc.—184,000 lb	80.00	100.00	80.00
19. Steel, concrete reinf.—750,000 lb	60.00	50.00	40.00
20. Steel, corrosion resisting—3,500 lb	560.00	1,000	670.00
21. Forgings, steel carbon—52,000 lb	100.00	150.00	70.00
22. Castings, steel, grade 0—25,000 lb	160.00	170.00	150.00
23. Metal, non-ferrous, misc.—25 lb	2.04	1.50	3.72
24. Castings, iron, malleable—7,400 lb	220.00	140.00	140.00
25. Pipe drain, 12 in.—250 lin.ft	2.25	2.50	2.40
26. Pipe, corr. metal, 60 in.—152.5 lin.ft	11.45	37.50	10.13
27. Pipe, corr. metal, 12 in.—28 lin.ft	2.21	5.00	2.32
28. Conduit, fiber, 3 in.—12,400 lin.ft	.37	.37	.46
29. Conduit, metal, 1 in.—180 lin.ft	.41	.57	.74
30. Conduit, metal, 3 in.—225 lin.ft	1.10	2.00	2.83
31. Elect. grounding system—total	476.00	400.00	178.71
32. Floor grating, steel—9,500 sq.ft	1.04	1.00	1.34
33. Tile gage—52 lin.ft	6.95	6.00	7.45
34. Field office—total	1,000.00	3,469.00	4,260.00
35. Chromium steel—1,400 lb	.15	.31	.16

Ocean Outfall Pipeline, Los Angeles

CONSTRUCTION of a 4,971-ft. submerged pipe line, 60 in. in diameter, started in July, 1935, under the jurisdiction of A. K. Warren, chief engineer of the County Sanitation Disrtict of Los Angeles. The first 2,260 ft. of the line will be entirely embedded in tremie concrete below the bed of the ocean with the remainder being laid on the bottom. The work consists of 667 ft. of double pipe line, 4,304 ft. of single pipe line, and 21 manholes, with a cutoff wall and diffuser structure at the ocean end. Alternatives were taken on cast iron and reinforced-concrete pipe, with the latter type accepted for construction. The following tabulation lists the totals and unit prices of the three low bids submitted. The total is first given for concrete pipe, then on Cl.B. cast iron, followed by Cl. A & B combined. (A) Merritt-Chapman & Scott Corp., San Pedro, Cal. (contract), $528,059, $547,546, $534,065; (B) United Concrete Pipe Corp., Los Angeles, Cal., $691,738; (C) Pacific Bridge Co., San Francisco, Cal., $704,808, $741,198, $758,352.

OCEAN OUTFALL PIPELINE, LOS ANGELES

	A	B	C
1. Cut off wall—total	$6,694	$7,500	$6,000
2. Dble. pipe line, 60 in. C.I. Cl. A—667 lin.ft	231.00	.....	281.00
2a. Dble. pipe line, Cl. B alternative—667 lin.ft	241.30	.....	290.00
2b. Dble. pipe line, 60 in. reinf. conc.—667 lin.ft	237.00	374.00	274.20
3. Single pipe line, 60 in. C.I. Cl. A—1,593 lin.ft	109.00	.....	158.00
3a. Single pipe line, Cl. B alternative—1,593 lin.ft	113.15	.....	165.00
3b. Single pipe line, 60p in. reinf. conc.—1,593 lin.ft	110.00	163.00	150.00
4. Single pipe line, 60p in. C.I.—550 lin.ft	98.50	.....	107.00
4a. Single pipe line, 60 in. reinf. conc.—550 lin.ft	100.00	116.50	100.00
5. Single pipe line, 60 in. C.I.—2,161 lin.ft	64.75	.....	107.00
5a. Single pipe line, 60 in. reinf. conc.—2,161 lin.ft	59.00	53.70	100.00
6. Diffusor structure—total	5,557	2,500	6,000

Outfall Sewer Tunnel, Los Angeles

CONTRACTS were awarded in July, 1935, for the construction in three sections of the tunnel portion of the White's Point Joint Outfall Sewer, west of San Pedro, Cal., as projected by the Los Angeles County Sanitary District, A. K. Warren, chief engr. The work consists of 31,115 ft. horseshoe section reinforced-concrete tunnel, 8 ft. in diameter; 960 ft. of reinforced concrete 8-ft. conduit; 120 ft. of double line 60-in. cast iron pipe; and the construction of reinforced concrete manhole structures, and transition and valve chamber connecting the tunnel to the ocean outfall pipes. Following are the unit bid tabulations and totals of the three low bidders on each schedule: I—(A) Schofner & Gordon, Los Angeles (contract), $629,967; (B) Morrison-Knudsen Co., Los Angeles, $636,790; (C) Broderick & Gordon, Denver, Colo., $654,245. II—(D) Broderick & Gordon (contract), $897,695; (E) Shofner & Gordon, $976,314; (F) L. E. Dixon & Co., Los Angeles, $1,101,813. III—(G) United Concrete Pipe Corp., Los Angeles (contract), $440,058; (H) Artukovich Bros. & Bebeck & Brkich, Hynes, Cal., $445,405; (I) Shofner & Gordon, $524,898.

TUNNEL SECTION, LOS ANGELES OUTFALL SEWER

	Schedule I				Schedule II				Schedule III			
Items	Quan.	A	B	C	Quan	D	E	F	Quan.	G	H	I
1. Tunnel access works—total	.....	$30,000	$6,000	$5,000	.....	$10,000	$46,167	$78,833	.....	$6,000	$8,000	$20,000
2. Tunnel section excav.—cu.yd	34,000	8.45	8.25	10.60	50,000	9.75	9.50	12.00	28,000	6.00	6.21	8.00
3. Tunnel enlargement excav.—cu.yd	200	15.00	10.00	12.00	300	12.00	15.00	12.00	100	12.00	9.00	15.00
4. Pipe line, dble. 60 in.C.I.—lin.ft	120	40.00	50.00	83.33	.....	.....	.....	.....	.....	.....	.....	.....
5. Manholes, transition chambers—total	.....	6,000	8,400	7,500	.....	.....	.....	.....	.....	.....	.....	.....
6. Conduit, reinf. concrete, 8 ft.—lin.ft	.....	.....	.....	.....	.....	.....	.....	.....	960	50.00	36.44	35.00
7. Tunnel concrete—cu.yd	13,000	12.25	12.75	12.25	19,100	12.25	12.55	11.00	10,200	11.74	9.45	13.57
8. Tunnel steel supports—ton	280	117.00	135.00	100.00	365	100.00	117.00	100.00	105	100.00	153.00	17.00
9. Tunnel timbering—M.B.M	525	50.00	85.00	30.00	1,000	30.00	50.00	61.00	800	40.00	70.00	50.00
10. Reinforcing steel—lb	1,402,000	.041	.045	.035	2,207,000	.035	.041	.04	1,289,000	.04	.042	.041
11. Granite coating, tunnel rock—cu.yd	125	25.00	25.00	15.00	125	15.00	10.00	20.00	50	15.00	30.00	10.00
12. Drill grout holes—lin.ft	5,000	.50	.50	.40	5,000	.40	.50	.50	500	1.00	1.50	50.00
13. Grout connections—each	1,000	2.50	2.00	1.00	1,000	1.00	2.50	1.00	100	3.00	3.00	2.50
14. Grouting—cu.yd	600	15.00	25.00	20.00	700	20.00	25.00	25.00	50	30.00	50.00	25.00